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THE

PHILOSOPHY OF PHYSICS

OR,

Process of Creative Development,

BY WHICH

THE FIRST PRINCIPLES OF PHYSICS ARE PROVED BEYOND CONTROVERSY, AND
THEIR EFFECT IN THE FORMATION OF ALL PHYSICAL THINGS MADE
COMPREHENSIBLE TO ALL INTELLIGENT MINDS,

AS IN

PHENOMENAL NATURE.

BY ANDREW BROWN,

MEMBER OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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PREFACE.

THE present work is introduced to the world by the author under the following circumstances:

Being somewhat critically observant of the phenomenal facts of physical nature, in their general and wide-spread relations, and of mankind's method of philosophizing on their cause, and not being over-credulous in taking for granted even what the greatest sages may have said on this subject without being first satisfied with the soundness of the principles on which they based their belief, we were soon led to question the legitimacy of the relation thus attempted to be established between these phenomenal facts themselves and the laws or rules usually assigned and assumed as governing their action, between which there were found too little parallelism to induce the unquestioned adoption of even any of the theoretical views promulgated by physicists.

The more this investigation was pursued, the more divergent became these lines of assumed parallelism thus supposed to be established between the facts of physics and the prevalent philosophy of physics. Therefore thus failing to find the requisite relation between the phenomenalities of nature and the dynamicalities of nature where others had supposed them established, and being fully satisfied that the phenomena of nature are but the creatures of nature's rule of right, and consequently as having a ruling cause in every particular parallel with the observed facts; and being at the same time fully satisfied that nature, in her phenomenal severality, however infinite, is but the sensible expression of her unitality of purpose, we were induced to search for a system that would better harmonize the relation of cause and effect, and be in accordance with that rule which nature has prescribed for her conduct, seeing that these phenomena of nature are only to be regarded as the sensible expressions of nature's law.

But this search for the unital forces effective of physics among the dynamical systems assumed by physicists, or even among her own phe nomenal severalities, agreeable to the inductive doctrine which the world now recognizes as being the most safe, or, indeed, the only sure method by which conclusions of sound character can be arrived at at all, still continued to be of that unsatisfactory character from which nothing could be conclusively established, but much that was contradictory constantly manifesting itself. The idea was conceived (though contrary to the counselings of the-most approved teachers) to invert the order of research, and endeavor to deduce the order of nature from the principles fundamental of nature, or elements as necessarily *à priori* of all physics. With the workings of this scheme we have had infinite reason to be well satisfied; for it has been equal to every inquiry, it has resolved every problem, it has *incontrovertibly* determined every fact, and established every relation; it has proved to be a revelation of that for which mankind have been more or less in search for six thousand years. It has, indeed, proved to be the scheme, process, and accomplishment of the whole physical universe in every phase of its development or form in its infinity of progression; from the radicalism of atoms to the revolution of solar systems; from the constituent parts to the eternal whole: from the integrity of elements to the eternal mutation of things; from the first conception to the final consummation; or from Omnipresent thought to Omnipotent expression—being the entire relation between the physical universe and its Maker, or between physics and the God of physics.

The scheme was sought for, in the first place, for self-satisfaction merely, and with no views with reference to the world's being made any the wiser; but since its conception, and the satisfaction it has afforded us, and seeing in every physical work to which we have since had reference a manifestation of the necessity and search that mankind are constantly making for the truths this system of inquiry has established so conclusively, we were induced to the idea that it would not be well that a system so certain in its phenomenal determinations should be lost to the world; and willing that physical science should have what benefit there might be from our labors, we reluctantly, but finally, concluded to use our best endeavors to put our discoveries in the best shape our descriptive abilities would enable us, and present them to the world with the fond hope that we may have so far succeeded in making the matter intelligible, as at least to serve as a formula, by which the scheme of creation can be traced to what we may call a finality; for in nature there is no other method but in the measures that she herself has adopted for her own development.

But our confidence is by no means as strong in our ability to communicate comprehensively to others the scheme we have deduced for ourselves, as it is in the validity of this creative scheme itself, which we have found to be so effectual.

But should we be successful in making ourself intelligible to those who cultivate scientific research we shall have secured our reward; and were ambition our aim, in what merit there may be in being thus made the active instrument of such momentous revelations—for whose introduction we assume the world to be now well prepared—it would require no prophetic finger to point to the prospective emblazonry on the loftiest pinnacle of the tallest tower of Fame's triumphant temple, where these truths of nature will finally find their place. We thus propose no unhallowed profanation of that most sacred fane, being fully aware that to its high honors no pretending arrogance can find access; but with full and submissive faith in the facts we assume to have found, being the fundamental truths of physical nature, we can not but contemplate the high position which must be assigned them; nor can we be insensible to the distinction conferred in being made the first messenger to mankind of the only method by which the whole problem of physics can be uncontrovertibly solved, and in the manner which we have attempted to set forth in this work, which, with all due submission, we now present to the public.

INTRODUCTION.

"In the beginning God created the Heavens and the Earth." We not only have the great fact of the physical creation thus declared by the Creator himself, but we likewise have the same testified to by every phenomena in nature; all bear equal evidence of the same great source of origin. The human intellect itself, and the countless objects of its contemplation, are but so many expressive manifestations of the originating powers of some great principle. But this incontrovertible fact, thus strongly enforced, is not enough to satisfy the intelligences to whom the communication is made; they being a reflex germination of that all-originating power, can attain full development only in Infinite conception, nor full contentment until they reach the root of all things, and are fully able to perceive the processes by which the creation of the Heavens and the Earth was accomplished. And as there is no greater manifestation of God in the creation of worlds than there is in the fitness of all things, we may safely infer that we are not forbidden the exercise of our faculties in investigating the phenomenal processes of that Power who imparted such faculties that we might thus use them.

We can not therefore consider it as trespassing, where the hand of welcome is so evidently held out. But as these faculties are finite, and but imperfectly developed, there may have been much misconception of "the handwriting on the wall," both as to what God has *said* in His divine records of the creation, and likewise of the phenomenal characters recorded in that creation itself. It will be proper, therefore, in the first place, to ascertain how far the usual conceptions of men coincide with the creations of God, that we may know what need we have for any other scheme of creative development than that supposed to be declared by God himself, or that has otherwise been conceived of by man. If the scheme of physical creation is already understood, there is nothing further to do; but should our suggestion be right, that the ways of God have been misapprehended by men, we then see the necessity for a system in which greater dependence can be placed.

As an evidence of the little dependence to be placed in finite conceptions, we find it could not even properly construe what was admitted to be the inspired teachings of Jehovah; for all mankind, until a very recent period—and many of them even now—understood the records of creation so literally, as to suppose that in a period of six diurnal revolutions of the earth the Almighty created all things, and made the earth a suitable abode for the prototypes of all the organisms that now occupy its extended surface. This construction of the inspired record was not seriously questioned until geologists found it would not coincide with those phenomenal facts of an antiquity about which there can be no mistake. Now that this observation has been made—and no one thinks of imputing discrepancy between the works of God and the words of God, whether chronicled in the rocks of the earth or in the records of inspiration—the error must be admitted to have been in man's misconception of the inspired teachings, and not in the teachings themselves. When this six-day system of creation was universally prevalent, mankind were confident they could have made no mistake in the information imparted; for who could better know, or communicate with greater precision, than the Almighty narrator, who was admitted to have the capacity so to create? There was in such a case nothing further to contemplate, and consequently but little left to philosophize about. Who could undertake to fathom a process, thus projected by Almighty Will, into the interminable fields of eternity, and in such short period as to imply no process save the immediate volition of that will?

The power thus to create being so infinitely beyond any power created, may well have precluded all speculation or questioning with respect to the creative act, and more particularly when all the facts in the case were understood to be reported by the Creator himself. This long-prevalent belief in what God himself was supposed to have immediately done and taught, is now found to be erroneous, and the door thereby opened for finite teachers and speculative philosophers; and what surety is there that they will more correctly interpret the records of nature than they have done the records of inspiration? It will require more than we have yet seen in the discussions on this subject before general physics can be received as a true science; for in all the teachings of physicists there is a decided want of that general harmony as a whole which we conceive should characterize the creations of God, with respect to whose character there is as much misconception as there has been, and now is, about his phenomenal or inspired chroniclings. He being unity, and the source of all existences, nature must necessarily be the perfection of unital severalty, making manifest expression of the principle of their origin; hence any misconception of the effective attributes of this power must necessarily mar the possibility of a perfect appreciation of his formative processes.

The six-day idea of creative effectivity is not the only great error into which mankind have fallen respecting this creation, for the very term itself, "to create," we conceive to be misconstrued; for we find the general impression is, that a creation by God is a something originated from nothing, which is an erroneous idea. We find nothing to justify such interpretation. In the statement that "God created the Heavens and the Earth," although very conclusive of the fact that they did not previously exist, and that there was an origin to physical nature, and that God was the author, still there is nothing conclusive of their having been created out of nothing. We conceive the inference to be altogether gratuitous; from the statement, we can only infer that there was instituted and developed a new order of things, comprehending physical nature; but had there been no previous nature, this physical nature could by no possibility have been evolved. We are by no means justified in the inference that when God created the infinity of bodies in the firmament of heaven, that it was a special and final creation of these bodies from nothing, with their elementary properties immediately emanating from Him; for in that case they must have partaken of His immutability.

The elements of physical nature may be recognized as capable of having originated something new, by a resolution of new conditions, and such may have been accomplished by certain effective associations among primary principles themselves; but they could by no possibility have originated themselves by any self-creative act; neither could they of themselves have formed such effective combinations as caused the phenomena of nature, without the instrumentality of some power capable of discriminating for them; therefore, as we perceive, Infinite Wisdom was virtually the creator of physical nature.

The elements of physical nature could have been self or associatingly existent with the Author of all, but they could not have been self-generative; neither could the power by which they were made practically applicable, for He (no more than they) could originate no new principle or attribute of His own existence, by willing from nothing into actual being the principles with which to construct the physical fabric. Out of, or from himself, the heavens could not have been originated; for he comprehendeth eternity, and physical nature is but the expression of his own inherent principles, and these could never have been imperfect, or have originated in nothing. These principles being in him, must have been forever with him, as attributes of his own character, and consequently not requiring to be created from nothing. Seeing, therefore, that agreeable to the immutability of the creative character, there could not have been a creation of the elementary principles of physics from nothing, we have much less reason to infer that there could have been any such direct creation of the heavenly bodies in mass as is usually assumed to have taken place in six days.

The heavenly bodies, with all the physical phenomena in nature, are to be regarded as only sensible manifestations of the affectivity of ever-existing principles, *à priori*, of physics, and as called into action by the all-ruling will. We should not suppose it difficult to perceive the distinction between expressions of ultimate elements and their creation from nothing, or between phenomena as they are, and their ultimate roots.

The elements of things are the initial terms of expression, and ultimate Causation would have been insufficient in capacity had he ever been without the means physically to express himself. Thus we find that physical nature must have had a progressive development through the instrumentality of ultimate elements, and not in the special and final fiat of Almighty mind; and these first principles must have ever been associated with, and inseparable from, primary causation, or there could have been no integrity to his character.

This great First Cause could have given expression to his counsels, in the formation of phenomena, only by the ability resident in himself; and it would be absurd to suppose he had to *create* in himself that ability. There could not have been a period at or before the physical beginning, in which this ability did not exist; to assume otherwise, would be to assert that God himself was a principle of progressive development, by thus begetting in himself powers for the greater perfection of his own character. Now we assume that no one will for a moment entertain such an idea, as that would imply an imperfection in perfection's self.

We thus demonstrate the ability of the God of nature to originate and evolve a universe without creating from nothing any of its first principles, because every created thing must have originated with him, as the effect of principles existing only in him; and these principles could not have affected the physical creation, except through his will.

Thus perceiving that the ultimate elements of physics are the essential attributes of God, we must at the same time perceive the necessity of ascertaining what is the true character of these attributes; for no proper conception of physical nature, as a science of cause and effect, can be obtained without a just appreciation of these first principles. As primary causation must be immutable in character, so must his attributable principles, which are the elements of physics; and this has to be reconciled with the infinity of change everywhere presented in physical action; and as the problem of physics can only be solved by the rudimental principles of physics, the most important question is, What were or are these eternally steadfast principles of metaphysical unity? what their course of conduct, by which such an infinity of severality and change is produced?

Philosophers have, so far as we can perceive, totally failed in designating any order of ultimate principles having such integrity of character; they are certainly not among sensible things, for every sensible existence is secondary and mutable. The heavens and the earth, and their phenomena, in their present palpable forms, are but the effect of elementary principles, and could not have been created of God at the beginning, for in that case they could not have been changed from the condition in which they were created. All sensible things being secondary, are constantly subject to change; being but the expressive effect of the physical action of ultimate principles, if such principles were to cease their action, there would be neither heavens nor earth; all would instantly be, as if there never had been, a beginning; but even then there would be no less reality than now, for the constituent principles of the heavens and the earth could by no possibility be annihilated.

As there was a beginning, they must, anterior to such time, have been so conditioned as not to be able to form a universe, but they can never be so conditioned again; their physical characteristics can never be subject to subsequent abrogations while God retains his integrity.

While we thus perceive that all needful and possible things are necessarily a product of the Almighty-originating power, we likewise perceive it could have been neither needful or possible that he should have given effect to the immediate evolution of the mighty masses of matter as they now exist in space.

We may with about as much propriety assume that nothing could originate something, as to suppose that the primary Essence of all things should, by an immediate act of his being, evolve worlds in their gross proportions.

From what part, or by what effort of this primary Omnipresence, could such monstrous productions have been propagated? or by what concentration of this eternally-continuous power could such masses have been sent whirling into interminable space with such motions and powers of self-perpetuation as ruled their relative positions?

Are we to infer that the creative energies of Almighty God would have been concentrated in those divisions of space where we observe material masses? Such could not have been in accordance with his universal and omnipresent character; neither could he have occupied himself in the production of body after body, or system after system, for it can not be in the character of that Power to concentrate in such partiality; but if he could, it would follow that in such a repetition of creations there never could be any end to the creative effort, while to the eternity of space there is no termination.

And had one solar system been creatively introduced after another (as nebulists now suppose), this would have caused a constant disturbance of their relative adjustment in space—so there could be no permanency.

While in this we see that the physical universe could not have been formed by any system of successive creations, it must be equally evident that this Omnipresent Being could not have simultaneously originated and perfected all by the immediately effective operation of his own direct power, concentrated at such alternating intervals in the eternal expanse.

These are important reflections, and particularly for those who assume that all things were created by God at the beginning, agreeable to the six-day supposition; for he being the source of all power, and in continued occupancy of all space, we may, without presumption, ask by what application of this power, or by what concentration of omnipotent effort such mighty masses were at once originated and projected—one here, another there—one with this velocity, and another with that, in all the order of their primary and subordinate groupings?

Agreeable to this doctrine, and in accordance with the prevalent philosophy of motion, we find that force and motion are equal; we may therefore compute, or at least conjecture, what would be the immensity of force now requisite to bring any or all of the planetary bodies to rest, and such would have been the force exercised in the beginning to impart their present velocity to these bodies.. All the motions of all the planets, in all the solar systems of the universe, are necessarily imparted by some competent force, about which physicists are much mistaken, for they define it to be only an impetus imparted by their Omnipotent Originator. But had these moving masses been the immediate generations of this great power, or had their motions been directly imparted by him, there could be no power in nature, or in the God of nature, by which either mass or motion could be changed; for no mutable thing could have emanated from an immutable principle; for the fiat of God can not be changed, and his integrity stand fast.

There certainly is no proposition more incontrovertible than this, which furnishes the most conclusive evidence that neither the heavens nor the earth, as we comprehend them, were originated by God in that manner in which Scriptural record is usually construed. And should further proof be required that such was not the case, it will be found in the fact that all phenomenal conditions are secondary, and constantly subject to change; and that all the observed activities of nature are constantly fluctuating; which testifies to a system of progressive development through an infinity of change.

In the physical economy of nature we find no evidence of any thing having been effected by the direct act of creative will; but rather of agencies, or elementary principles instituted and actuated by that will. Such agencies must have been the cause, not only of the visible heavens, but of every visible thing in the universe. All the phenomena of nature in sensible forms are but conditions induced by agencies already existing. Hence, we perceive, that nothing is really a creation, agreeable to the abstract sense of the term. Thus we find that even had geologists never brought to light the entombed records of the earth's ancient chronology, it would not have been difficult to have discovered that the creation could not have been originated and perfected in the six-day period so usually assigned to it; but that it must have been by the progressive effect of principles acting through untold time; hence it must be by these principles that physicists can hope to fathom the mysteries of creation, or even to understand in what creation really consists; for it will not be found that first principles are other than attributes of the all-creating Power. So physical nature is necessarily consequent from the effectivity of these attributes, excited into action by the Infinite Mind, therefore they could not have been creations, neither could they have created something from nothing, consequently there was nothing for them to act on but each other. Hence physical nature must be but the effect of this action, operating by the will of God upon the attributes of his own self-existing character, giving sensible and creative expression to this will; hence we must perceive that physical expression is the creative effect of *will*, acting on principles of indestructive and uncreated existence.

While the visible universe therefore is subject to incessant change by combinations of form (the effect of first principles), these principles themselves, being attributes of the Almighty, are not subject to mutation. Now however important it may be for physicists to understand properly the character of elementary principles, we do not find that they have been at all successful in demonstrating, or even indicating, what first principles are. This is certainly unfortunate, for it is evident they must have existed before there could have been any creation or beginning of visible things, and even whether they may have had a retrospective eternity or not, their nature must have been equally the same: and as they were the essentials in physical construction, they must be equally so in its solution.

Physical existence, having had its origin in metaphysical existence, which is beyond our physical powers of recognition, and beyond any test we can apply, it must necessarily follow that the ultimate roots of physical nature are not objects of physical scrutiny, but must be investigated by the exercise of our higher powers of perception applied to metaphysical existences, of which were the elements of physics in their abstract condition, and in this condition could have had no shape or form as we comprehend them. But as physical nature must have been eternally involved in the great metaphysical First Cause, it was virtually and effectually created or evolved by that power, and as the physical scheme must have been ever present in the councils of Infinite Intelligence, the fundamental characters for its constitution could never have been absent, they being the principles by which expression could be given to this great physical scheme. As it will be admitted that there are principles fundamentally expressive of physics, it would be absurd at the same time to assume that the material worlds, in any part of their massiveness or motion, were originated by the immediate effort of mind, for having such a source; if they were adequate to any thing, they would be equal to every thing: therefore the active principles of ultimate character must have been instituted for other purposes than to redeem chaotic worlds from confusion. There certainly would be much more consistency in the assumption that nature was progressively evolved by the operation of ultimate principles, and in that case, whatever may have been the progressive conditions, none of them could have been chaotic; for the elements being the only operative agencies, could not have caused discord in their own doings;

hence we may infer that there could have been no evolution of visible masses "without form and void."

Surely, if any system of elementary principles were essential for the structure, regulation, and government of planetary masses, Omnipotent Wisdom would have availed himself of their instrumentality for the full evolution of such bodies, as much as for their subsequent control, for there could have been no necessity for anticipating their action by an immediate production of any part of the work assigned them to do. When we contemplate the character of the Creative Power, we must come to the conclusion, that nothing in nature could ever have needed the institution of special or provisional powers to rule to order the confused effects of any existing forces; for the elements of physics being the essences of truth, their phenomenal effects could never have been in perversion.

The evidences of design in the creation leave no question but that Infinite Mind was the exciting cause by which physical nature was consummated in all its complicated relations.

He ruled the ruling powers when he imparted to them their physical activity. He originated systems of worlds without end, and ruled them to their relative positions and motions when he imparted energy to matter; and these positions and motions they perpetuate by their own self-regulating machinery. But the forces by which all this was effected, what are they? Finite mind can not hope to fathom the profundities of a universal system of nature, perfected by a system of means of which it knows neither the nature nor character; and we certainly conceive that physical inquirers have been so far unsuccessful in their discovery or adoption of any system of universal dynamics that consistently accounts for the infinite phenomena of that nature; for we still find them under the necessity of making references to the immediate act of the great First Cause to account for many important facts.

This may be a convenient philosophy for those who are disposed to follow it, or who can not otherwise account for physical expression, but it can not be considered as by any means a profound one. To assign physical causes for any of the facts of nature, and then fall back on primary causation for what their measures will not supply, is full proof that the system is unsound; for the true principles of nature must be in all things the principles of nature. What could have begat any thing, must generate every thing, or the Principle in which they originate can not be perfect. The powers imparted would be equal to the ends intended; for He could not miscalculate his measures or come short of his objects.

Hence, when physical causes are found to be effective of phenomena, so far as finite powers can penetrate, this is the best evidence that all things are the effect of physical causes. Initial elements being admitted as the origin of every thing within the sphere of our comprehension, leaves us but little right to infer that these elements cease their action when we fail to recognize their effect. The greatest penetrable depths must still be at a vast remove from the metaphysical abstractions by which physical objects are made manifest. Finite powers may, in many instances, be unable to effect a change in physical conditions; but that does not prove their insusceptibility of change. But changeableness does not apply to the initial properties; if it did, there would be no stability to the universe.

If the problem of physics can only be solved by a proper understanding of its elementary principles, our first endeavor should be to find out what these really are. We find matter acting a most conspicuous part in this existence, yet physicists have not determined what its abstract character is. In its sensible forms it is known to be of an infinity of kinds, qualities, and conditions, with most of which, through the medium of our senses, we are in intimate relation; and this leads to the supposition that if we can acquire a proper conception of any principle of nature, it must be that of the material.

If we take counsel of physical science, we find that matter is not an abstract quality, but consists of over fifty simple abstractions or kinds, with its number every day augmenting.

We are at a loss how to treat respectfully the reasoning that can make this so evidently absurd system of elementary finalities a foundation for its philosophy. If the self-evident absurdity of a multiplication, or even a plurality of kinds, to the same simple essence, is not in itself sufficient to stagger the faith of physicists, we may well despair of disturbing their credulity.

As kinds necessarily imply characteristics by which they might be designated from each other, how could it be possible for a simple abstraction, having but one property, to be so separable into kinds? The conditions of physical matter are unquestionably infinite, but matter in its metaphysical state can have but one positive quality; and however separable or multiplied such matter may be, each component atom of any substance would in itself be precisely as every other component atom, they in their ultimate state being void of the formative faculty by which kinds could be constructed. Matter, by its admitted indestructibility, may properly be regarded as a primary principle, but not as primary principles. The whole subject of simple materiality, therefore, narrows itself down to the single question of, What is the true character of this all-important abstraction? For independent of the fact of a simple thing being inseparable into kinds, matter being—as we have seen—an essential and immutable attribute of the eternal First Cause, could not have been in him a multiplied plurality, with characteristics differently designable; nor can this principle have a partial distribution in space, whatever its present sensible conditions; for, being an attribute of the eternal Omnipresence, we can not conceive of it but as coextensive with him. Thus we see several reasons why there could have been no possibility by which matter, as an eternal principle of the great First Cause, and everywhere present with him, or even as a primary abstraction, could either have changed or multiplied into kinds, or in any way modified its condition, *per se*, into any system of phenomenal differentiality by which designations could have been made. The only positive attribute of this principle must have been its indestructibility, or substantive quality not subject to annihilation, while its opposite or negative term was the absoluteness of its passivity: inert, in the most resistless sense of the term, must have been the attribute inherent in primary matter. It could not have been in the most distant iota disobedient to the energy of Omnipotent Will, which would have been the case had it been aught but the perfection of passivity, or had it possessed a quality in kind that could have been changed.

There is certainly an easy distinction between a positive principle of action and a negative principle of passivity in the object acted upon; hence activity and materiality are evidently separable properties.

But even had it been essential to the existence of matter that it should have been active, what are we to conceive as the principle governing such action so as to produce the ever-changing phenomena of nature?

Activity is with an object for an end; but what could have directed such activity to such end? For. being thus independent and self-effective, it could not have been by the immediate superintendence and control of Infinite Mind, neither could it have had self-discriminating ability with this self-effectivity by which to direct aright any inherent powers of resistance or action; neither could any such inherent power of matter have been acted on by Omnipotent Mind for the forthcoming of phenomena.

Although matter in its ultimate state could have none of those positive properties or qualities (except its own indestructibility) so usually attributed to it by physicists, and though it must have been infinitely passive, we must at the same time be satisfied that nature has, by her own proper method of formative effectivity, evolved the phenomena of nature, and we have seen this could not have been done by any combination of the several elementary kinds of the material principle, there being no such severality of this simple essence, and with matter no phenomenal effect whatever; for no simple thing could be effective, *per se*. Now this is a dilemma to which physicists are necessarily reduced by rigorous demonstration; for this simple but immutable characteristic of matter, though entitling it to the consideration of being an ultimate principle, still is in itself one from which nothing could have been made, therefore could not form the only foundational root of physical science. Under it, as an abstraction, what becomes of the composition of forces by which astronomers calculate the motion of planetary masses? they are material bodies, but wherein could be their native inertia, which physicists call the first law of motion. While we grant all the matter that was requisite for these masses, still we have demonstrated it to have been in its native condition infinitely passive; and how can an inertial force be attributed to a passive mass? Seeing that such assignation would be absolutely absurd, it must follow that their inertial or first law of motion must be a fiction, passivity and power being diametrically opposite characteristics.

This being the fate of that branch of physical science for which so much perfection is claimed, what shall we say for the science of chemistry, whose complex combinations and forms of affinity seem to be infinite? We see that this matter in itself could have constituted none of them, it having none of those geometrical or qualitative specialities that speculators in that science so usually attribute to matter. Astronomical masses and motions, or characteristic combinations and complexities of chemical ingredients not being by the constructions, combinations, or effectivities of the several ultimate kinds of this substance, neither can the groups, orders, or systems of rocks in which geological science has its foundation.

For these worlds, these motions, or any of these substantive conditions, this ultimate matter would in itself have been altogether ineffective. Therefore those physical sciences, in their dynamical data, are all equally founded in error. Now that we have conclusively demonstrated that none of the phenomenal facts of physics could have been the immediate expression either of matter or mind, single or associate, they being as abstractions altogether ineffective, either upon themselves or each other, the physical sciences may still assume to have a foundation in the dynamical forces by which phenomena are effectuated; but it will be as easy to demonstrate that the *forces* which physicists assume to be fundamental are altogether as ineffective for phenomena, as it was to show the inefficiency of the abstract principles of either mind or matter.

As we have fully proved them to be at fault with respect to a multiplicity of materialities, so we will equally demonstrate their error with respect to their assumption of a plurality of the physical effectivities, or energetic forces, which in the sciences are assumed to be fundamental of physical things.

Should it be proved that they are in absolute error, both with respect to the initial character of matter and of force, there can be no foundation for their philosophy. Had they a true conception of the initial nature of matter, they could easily find the character of the force associated therewith, and the phenomena consequent therefrom; but while ignorant of both, their philosophy must be unsound.

Now this proper conception of the initial character of matter can be acquired by contemplating it as abstracted from all force; for when thus divested, its primary nature becomes a problem of self-resolution.

In physical discussions we are often reminded of the infinite divisibility of matter; but there must be a point beyond which this can not extend, and up to this point, however removed, such divisibility is conclusive of matter's being a secondary or forced condition; for divisibility has no application to ultimate or metaphysical matter, such as it was in the beginning, for there could have been nothing to divide; its initial character necessarily being but a simple integer, the beginning of all beginning—the root of all numbers—the initial of mass—the unit of magnitude—a mathematical point—an inextended atom. This must have been the true character of matter previous to physical action or energetic effectivity; and this is established by the fact, that, abstracted from energy, it could have had no separability, having had no affinitive attachments to be dissolved.

All must have been equal to all, and atom equal to atom, in this continuous ocean of material infinitesimality, which must have been cotemporaneously prevalent with intellectual Omnipresence, or there could have been no perfection in his character; nor could there have been any breach in this unity, not even to the extent of one single atom. This matter, thus conditioned, may have been perfect in its own inherent character, while it remained wholly ineffective for physics. This being the incontrovertible condition of primary matter at, and anterior to, any physical beginning, what becomes of the received axiom of every atom of matter in the universe attracting and being attracted by every other atom? or the equally preposterous proposition, that motion is as much the condition of matter as rest, on the assumed principle that force and motion are equal.

Now where is there any indication that force could have been at all essential to the intrinsic character of ultimate materiality, however necessary it may have been to its physical effectivity. There certainly can be no difficulty in perceiving that were the first proposition true, physical nature must have been a total failure, for such indiscriminate application of the attractive energy would speedily have consummated immutable frigidity. This would certainly be no evidence that wisdom was coextensive with matter; for by such application of force, the very first act of the First Cause would have been an effectual bar to all life-like activity, and a total frustration of the great scheme of creation.

Now, as God could not possibly be wrong in His application of the required forces, man must be altogether in error in his conception of a force that must inevitably have had this effect. Thus finding that the first proposition of a mutual attraction among the atoms of matter can not be true, as effecting their ultimate condition, or of this indiscriminate character in any condition, we turn to the second proposition, namely, that motion is as much the condition of matter as rest; and find this to be equally false, as matter in its ultimate state must have been infinitely passive, and in that case motion could not have been its condition, for having no latent power to resist, there could be no force of inertial momentum, while the law "of force and motion being equal," holds good; for a perfectly passive thing could have no momentum, however susceptible of motion it may have been, as the effect of a cause; still it could not have contained in itself that cause; therefore immobility, in place of motion, must have been the law of ultimate matter; hence for constant motion there must be a constant cause of motion, which cause can not be an inherent quality of matter, but of a principle operating on matter for a purpose, and constantly equal to all the conditions required in that purpose.

Now in this there is not the most distant indication of the inertial quality of matter, assumed by physicists as motion's first or inertial law. What was not in the abstract atoms of matter, can not be in the aggregates of matter, for such aggregates are themselves but the effect of a resident cause, originally attaching to the atomic constituents for physical effect; and when it required a force to disturb these aggregates from their state of rest, so as to impart motion, this resisting cause resident in the aggregates, would in its turn finally extinguish this induced force of motion, so that matter would return to its primitive rest. This very axiom of force and motion being equal proves this proposition to be sound under any circumstances, and that there is no continuous motion as the consequence of any initial impulsion, all continuous motion being the effect of continuous cause, the expression of a constant force. We not only find in this demonstrable condition of ultimate matter nothing from which we can infer an equality of atomic attraction, or that motion is as much a native condition as rest; but we have found that in these material infinitesimals there could not be *kinds*, as assumed by chemists and physicists in general, and that this unity of condition could not have been compensated in kind by any system of severalty in force, as applicable to this initial finality of atom, for in such a case to what could complex forces attach themselves? all matter being but a mathematical or metaphysical point, attachments could have constituted no plurality in kind, for as there were no severality in the atomic condition, they could not have been affected but by a unity of force; for no plurality of forces could have found unassociated residence in any initial point, nor could such associate forces have been effective but in their compound character. What now becomes of the complex forces of physicists, attractive, repulsive, and polarizing, on which their speculative schemes of physical nature are based? Physical nature could have had none of them; attractions and repulsions are in direct contradiction of each other; if operating from a point, they could have only been effective in neutralizing each other; therefore they can not be forces affecting the same atom, or operating from it upon others similarly affected; neither could these forces have been residents of the respective poles of an atom, for poles imply plurality, which is not an attribute of simple existence. Hence there could not have been a plurality of forces applicable to ultimate matter. As a plurality of forces could not apply to an ultimate atom, ultimate forces must have been equally inapplicable to any aggregate of atoms; because they being a secondary condition of matter, no primary condition of force could thereto apply; for by the disintegration of such aggregate, ultimate force would have been made liable to mutation, a condition of which no ultimate principle is susceptible.

Owing to the infinity of atomic infinitesimals of ultimate matter, physicists may still fancy they can have their fundamental severalties of kinds by a distribution of the several orders of what they assume to be ultimate forces, as affecting the severality of ultimate atoms. But this last hope for a system of ultimate severalties, even in energetic kind, however seemingly secure, we find to be equally subject to demolition; for we have only to inquire from whence a complexity of forces could originate? They could not have had their root in physics, because there must have been forces before there could have been physics. They could not have been self-creations or self-independent existences, because they could not have been effective except on the substantive roots of matter. They could not have originated with the great First Cause, for he being an immutable unity could not be a variable severalty. If he had attractions in progression, he could not have had principles in retrogression. If he could have made physical application of the attractive energy to the atomic roots, he could not have inoculated the same roots with the repulsive energy, for such antagonistical principles could constitute no part of his character: therefore such a contrariety of forces can neither be the attributes of God nor the ultimate forces of physics, a severalty in kind being altogether incompatible with a unity of character.

Thus we find it clearly demonstrable that a simple force and a simple substantive thing to be affected by that force, with Infinite Wisdom to direct its application, was all that could have been, and all that was, required to have been the physical attributes of either God or nature, at the beginning or now.

Thus we have demonstratively deduced the perfect demolition of all the dynamical differentialities and substantive insimilitudes that physicists assume to have characterized the ultimate principles of nature, and by which they have constantly sought (but without success) satisfactorily to account for phenomenal creation.

But this continual failure, though unfortunate, is not at all surprising, for it can neither be in accordance with the conduct of nature nor consistent with sound philosophy that there should be more than one conditional characteristic to ultimate mind, matter, or force.

As we have now incontrovertibly deduced the important fact, that with only *one form* of matter and one form of force the great formative Mind must have constructed the universe, there being no possibility by which any other formative characters could exist other than these triune units, mind, energy, and matter, and this being the case, none need hope for success in physical science except by the means and method adopted by physical nature's great Originator. Cause and consequence must have a perpetual parallelism, the facts of physics and the forces of physics being at all times equal to each other and to the eternal whole as unity; for in all nature there can be no independent expression of any of the facts of nature. This method of mind and this means of force being nature's sole originating attributes, must be truly recognized and rigorously consulted by those who hope successfully to trace the relation between cause and effect; these being the radicles of nature, must be the only foundation roots on which a true science of physics can be permanently erected.

When this rigorous rule of relations is recognized and adopted, it will certainly cause an entire revolution in the present systems of physical science, for in it philosophers will find that atoms are not equally attracted; and that motion is not so much the condition of matter as rest. And astronomers will not find the inertial feature in their initial law of motion, by which the relative position of planets are perpetuated, or the forces by which their fancy has assumed the explosion of planetary masses sending their severed fragments whirling in space in their eccentric circles.

In this true system of rigorous research geologists will find none of the forces from which they have assumed the upheavals of mountains, islands, and continents from the bottom of the ocean. In this unity of character and kind they will not find the mineralogical severality of their rocks or systems of rock, or from whence originated the rudimental materials of their constructive groupings, or the fires and fusions which are assumed to have melted and metamorphosed their materials.

In this unity of matter and simple speciality of force chemists will fail to recognize the laws or forces in their right relation, as effective of their phenomenal expression, by seeking in a multiplicity of ultimate unities for the rudimental forms from which to construct their chemical severalties.

This annihilation of almost all the principles on which the present systems of speculative philosophy are based may seem to leave too narrow a base on which to rear the whole physical superstructure of the universe. But with these simple and primary principles, insufficient as they may seem, we will now endeavor to deduce the process on its general principles by which all the phenomenal facts of nature are to be overtaken. And should our success fall short of our desire, in making evident to others what is clear to ourself, the failure will not be attributable to any defect in the general system whose exposition we have attempted, but to a deficiency in our powers of presenting the subject in a proper manner; in which case we will content ourself with the reflection, that we have at least said sufficient to indicate the only true way by which the relation of cause and effect may be traced with success in every department of phenomenal physics.

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THE

PHILOSOPHY OF PHYSICS.

Chapter One.

Attributes of Deity: Mind, Matter, and Energy; how Acting—Results—Elementary Properties of the Physical Structure.

By the voluntary dispensation of the all-ruling Will and great First Cause of all physical being, man has not only been made one of his living creatures, but he has at the same time been endowed with that measure of intellectuality by which he can contemplate the other creations and conditions by which he is surrounded; not only with reference to such conditions as are most immediately essential to his well-being, but that he might exercise this high power for the still more exalted purpose for which it seems to have been bestowed; for by means of this high qualification, all the ways of God are opened before him, even to the contemplation of the processes, laws, rules, and relationships of all physical creation, from its first inception through all its phenomenal phases to its present perfection. A very high privilege, surely, but one which is certainly his province, or he would not have been thus gifted with powers contemplative of conditions that are neither immediately effective of, or affected by, his physical necessities.

Now, with all becoming deference, let us assume this high privilege in an attempt to follow the Creator through the practical and progressive development of the physical universe, from its simple elements to its present high order. There may not seem much modesty in this pretension, which so far exceeds any thing that finite intellectuality has yet been able to achieve—that it may at first view be considered as impudent presumption, but let not a decision on that head be entered into prematurely; we will await the award when we are through.

There can be but one rule by which we may expect to pursue this investigation with safety and success, and that is that which was adopted by the Eternal Designer in contemplation of physical development. Our first inquiry, therefore, is what must have been the nature of that rule by which all things were to be determined. Now, as that rule must necessarily have been resident in the elements selected for the development of this grand conception, the elements themselves are the objects with which we have first to do. Therefore the *nature* of these elementary abstractions is surely no ordinary question; for if by their practical applications and combinations it pleased Creative Wisdom that the universe should be evolved, they could have been in no sense insufficient for the accomplishment of this mighty mission; and as physical nature never could have been unfolded but by their agency, the full revelation of nature's growth and grandeur will never be made but by their means.

We are well persuaded that man has yet made but small progress in the achievement of what we hold to be his high prerogative; but that is by no means surprising, for notwithstanding the vast powers of intellect he is continually bringing to bear on this important subject, he never can succeed by his present method of reasoning. The great misfortune is not in the powers themselves, but in their misapplication, for we find the persistent efforts of philosophers to be the working of this great physical problem backward. When we contemplate the scheme of nature as a constant progression from the unity of first principles, we can not conceive an ability in man to resolve a retrogradation down to those principles. For this order of inversion nature herself has no powers present or in reservation; and what is not in nature, can not be in man. The prosecution of physical research, therefore, in that order in which we unfortunately find investigators have hitherto thought proper to pursue their inquiries, can not possibly be crowned with that success which is its object. By what mental or physical possibility need any finite power expect to trace its way backward from sensible and tangible substances through all the labyrinthian subtilties of their combinations and characters to the ultimate essences in which they had their origin.

To find one's way in all the depths of nature from fabricated things to formative abstractions, which are in their own essences involved in formative thought, is certainly not to be accomplished by powers either finite or physical. Now, we find that it is by finite and physical senses and tests that philosophers have undertaken to feel or fathom their way down through the complex ocean of physical infinitude, from nature as it is, to the nature of the power in which it had its origin. This analytical system of pursuing physical science is certainly good so far as it goes, but it is of very short continuance; for, to make the most of it, there is only a determination of what are the sensible constituents of sensible substances; and while philosophers undertake by its powers to solve the whole problem of physical nature, the task will continue a hopeless one, at least while no other instrumentality is theirs, for by this short-sighted system of philosophizing we find the simple elements of to-day dissolving into the still more simple elements of to-morrow.

But were such change even no longer a consequence of this system of investigation, the last recognized substances assumed to be simples would be but the limit of analytical subdivision, so far as men's senses could follow; but certainly that would be no limit to the divisibility of matter or material characteristics. Our senses themselves, or any substance or test we have it in our power analytically to apply, exists but as the evidence of certain elementary combinations, let them be of as delicate a character as they may. This is certainly fatal to their pretensions of being to us indicators of what the elementary abstractions really are; for the very organization of our physical senses being themselves affected by physical combinations, by what powers can they be expected to designate, analyze, or realize the infinitesimals of their own being? Their special adaptations and functions are not for the finding of simples, but to fraternize with fabricated things for the pleasure and preservation of their own structures and the beings to whom they belong. We have a higher principle of being to which these organizations and functions of our nature are simply administrative, and therefore they should never be permitted the first place in directing our councils.

Our success in this fundamental department of all physical science can only be attainable by the exercise of this high attribute of our nature by which Heaven has exalted our species so far above all other organized beings. Our reasoning and deductive powers, whose limits may be somewhere in the far distant vista of unknown infinitude, must certainly be a much better directory for our finding the way to first principles than any artificial exhibitions can possibly be. We certainly should know that there must be, and are, certain unmistakable landmarks or beacons that can never misguide us; and of which we should by no means lose sight; for without their bearings, the physical navigator, however consummate his skill, must, without possibility of escape, plow forever in the fathomless oceans of profitless speculation and incertitude.

The exercise of this intellectual attribute of man upon the primary essences of physics or sources of their origin (which, so far as we can perceive, must be a direct emanation from, or attribute of, his Maker, under the rigorous rule of inferential induction),must be the only sure method by which we may ever hope to comprehend the true character of physical nature's everlasting landmarks. They being the root of things, are the only sure means by which we may ever hope to solve the stupendous problem of the universe.

We must, therefore, go to the root of their roots for their derivation; for the character of these ultimate principles is only to be deduced from the power which must necessarily have evolved them, and the attributes of that power can be comprehended by us only through the infinite phenomena with which we are everywhere surrounded, and which are the living and palpable evidence of ultimate principles having preceded them.

It certainly requires no great accumulation of argument to prove that powers or principles in the abstract must have existed *à priori* of every species of physical production; for the relevant proposition, however trite, is nevertheless true, that had there been a time when nothing existed, there never could have been a time when any thing could have existed; for a blank eternity could have been no more generative than a blank in time. Therefore the means were not only *à priori* of, but they must likewise have been in all things adequate to the ends.

That there was a beginning to the physical order of the universe, there can be no question, for all things bear testimony to that great truth. We find every sensible substance therein to be in a secondary or forced state, from which state they are ready at all times to return, on abrogation of their formative powers, from which it follows that pre-existing power must have effected their formation. This must certainly hold good in every phase of the physical process. Therefore force must have effected a beginning to which it must necessarily have been precedent, and consequently an attribute of being in retrospective perpetuity; and this is not all, for the unmistakable evidences there are in every department of universal nature of the adaptation of things to things, their objects and ends, in all their wide-spread relations constituting one harmonious and eternal whole, is certainly most significant of infinite wisdom, as well as power existing, as principles precedent of physics. Although the evidences of wisdom are as wide-spread as the objects by which it is indicated, still there is nothing in this infinity of matter and its forms from which we can infer that wisdom and matter are essentially and inseparably the same thing. And as every material substance is known to be reduceable down to what is understood to be its ultimate atoms, had it been essential to the existence of matter that it should have had wisdom, this wisdom would have been of equal distribution by its attachment to every individual atom; for being essential, they could have had no separate or individual existence, and each being thus equal to every other, there could have been no especial exercise of intelligent action. And even could intelligence have attached itself to the separable atoms of matter, that would be the best possible evidence they were not one and the same thing. While it is thus demonstrable that matter could have existed without intellectuality, it necessarily follows that matter in the abstract must have so existed, and there is nothing from which we can infer or contend that matter or mind are not two very different and distinct principles.

That eternally existing intelligence could have originated matter in its first estate, may be questionable; but there can be no question with respect to the positive exhibition of an infinity of wisdom, in the endless conditions or modifications of forms which matter has assumed in the structural economy of the universe. And as no simple thing could thus act *per se*, matter in itself could not have acted on itself, and would therefore have been ineffective of the generation of any phenomena. Whether, therefore, we may regard original and abstract matter as having a retrospective eternity, independent of Omnipotent mind, it could never have been known as such to sentient beings only through the operation of some energy not inherent in, or essential to, its nativity. Virtually and effectually, therefore, so far as the physical universe is fabricated of matter, it is one and the same whether mind evolved matter in its primary essence, and practiced upon it for the production of things, or participated therewith in a retrospective eternity of being. Without the action of these great arbiters of physical destiny, matter would have eternally remained a simple, passive, and profitless thing, known to no existence save that of its co-eternal associate.

This ultimate or abstract condition of matter could never have been changed by abstract wisdom, however infinite such may have been. These two principles must have remained perpetually ineffective of any physical thing; for even to make infinite wisdom physically evolvable, it necessarily required that energy of execution should be equal to the powers of conception; for these are the characteristics of a God, without which there could have been no conduct in physical economy; for however passively susceptible the primary atoms of matter may have been, simple and abstract intelligence, however comprehensive, could not have *willed* into their nature a new principle of force or action. *Energy*, therefore, is another attribute of high Heaven, and without its instrumentality expression could not have been given to creative thought.

But neither the wisdom of design nor energy of execution, although the essential attributes of God, could have been physically effective had not matter been co-eternal with or created by them. Therefore, as far as the development of the universe is concerned, matter may be regarded as a primary attribute of that same high Power; for without its agency nature would have been a nullity, as we find it an essential constituent in every physical body. Whatever may have been the origin of nature's materiality, whether a perpetual existence or subsequent production, we must regard it as one of the triune principles which form the godhead of nature, and in which that nature must alone have its substantive roots. This physical principle, therefore, must be looked upon as no common thing, as it has to be contemplated in character with its illustrious associates.

Can there be any thing in the constitution of physical being that was not in this primary association, or other than what is in these triune principles above-named? We would most assuredly say, nothing; nothing evident, nothing necessary; they are the Alpha and Omega of nature, and no one can possibly misunderstand the distinctive character of these associate principles. The one which comprehends all wisdom, and evolved the process by which the universe has been formed, is certainly not to be designated as one and the same with its material associate from which that universe has been constructed.

Neither can the energetic principle on which the construction must have been devolved, be essential to or inseparable from the existence of matter or mind. Wisdom, matter, and force are in themselves separable, and when so separated, they can only be regarded as simple existences, having no power *per se*, and hence effective of nothing; for, so far as physical development is concerned, what could the most consummate wisdom make of itself, without having matter in obedience to its volition? What would be the practical result of such volition were there not energy of will and wisdom of discrimination? These three principles, although in themselves purely metaphysical abstractions, when physically associated form the triune attributes of nature's great Originator; and as what is not in them can not be evolved by them, the whole universe must be but the practical and sensible expression of this triune association.

That we may properly construe the passages to this ultimate expression, and have a proper comprehension of the whole "handwriting on the wall," we must have a *key* to the characters that are impressed on the monuments that make up its whole; and as nature could not have impressed a characteristic that was not its own, this *key* can only be found in the primordial elements of the physical godhead, in the eternity of which must have been involved the physical universe; for if not from them, whence could it have come? But though everlastingly involved in the wise attribute of this tri-eternal power, it was only to be evolved at will, and awaiting that decision; for wisdom without a will, and energy at will, would have had no omnipotency; and if this will could have suspended creative effort or evolution for one moment of its being, it could have suspended it for any or all time. Energy being an attribute of, and constantly obedient to, this infinitely directed will, must have been made effective at pleasure.

Hence, in the beginning, God gave expression to this pleasure, *not* in the immediate or six days' creation of heaven and earth, as his own declaration literally construed has been usually understood, but in the much more strict accordance with the constituents of his own character, to which time has no attachable relation.

By what possible process that is to be conceived could these constituents of a physical Godhead have effected this almost immediate formation of the heavenly masses, even though "they were without form and void?" The omnipotent Cause of nature, while containing in himself the primary essence of all things, could not, as we shall see, by any direct or immediate effort, have evolved any sensible thing, much less masses of such magnitude as constitute the heavens and the earth. We certainly should not consider ourselves in such juxtaposition with the eternal elements of nature, as that there should be but one short move from infinite to finite, from the Essence of all things to structural magnitudes in their most massive development, without first satisfying ourselves with respect to the force by which all this could have been effected, and from whence such force could come. Certainly no such massiveness could have been the work of wisdom's single achievement; for though wisdom be an attribute of the Most High, we have found it would have been effective of nothing had not energy (or what is usually called force) been an associate attribute; neither could this association have so effected the existence of the heavenly bodies, because the omnipresence of primordial existence could not have thus gathered itself together in such partial concentrations as thus to exercise its powers in *spots*, as we may call material masses when compassed with the vastness of intermediate space. Principles productive of things being everywhere alike present, must necessarily have been everywhere alike effective, so that by no immediate effort could they have caused an intermixture of material masses with the eternal regions of vacuity. Even matter itself, if considered as an immediate associate of the great First Cause of physical production, must have equally occupied an entire possession of the everlasting expanse, with the wisdom and power by which it could thus have been so partially operated upon; for if at all unequal in diffusion, the eternal principle of physics would have been alternatingly incomplete.

And, as is the usual supposition, had the matter constituting these masses been a special emanation from the first Source of all things, which in itself must have been everywhere equal, by what possible process could these partial generations have been effected? It would surely be absurd to suppose the primary essence of all things emitting from itself, or generating in itself, such monstrous protuberances or excretions of grossly fabricated matter as make up the heavenly masses. Thus contemplating the character and attributes of God, in connection with physical development, we have nothing on which to rest our faith in the physical framework of heaven having been effected, in all the moving majesty of its mechanism, by any such a sudden impulse of power as that to which the divine proclamation (in its preversion) has usually been understood to mean. Neither can we perceive the urgency that could have actuated Omnipotent Mind in making any particular period (reduced to a point in the interminable annals of eternity) the time when this mighty effort should be made so special, effective, and final.

Being satisfied that there could have been no such creation of the heavens and the earth, we must, as already intimated, endeavor to ascertain the character of the elements everlastingly existing, what has been the process of powers resident in themselves, by which they have been transformed into their present conditions, without reference to *time*, for that is really the true consideration, with respect to such formations or conditions, of which we find there is an infinity. But of *creations* proper, that is, in the sense which signifies something from nothing, there never could have been in God's government any such a phenomenon, for no deficiency could ever have prevailed in his eternal dominions; what did not always exist could not now exist, nothing has ever been added, and nothing been lost. This may, and no doubt will, be looked upon not only as a startling proposition, but, perhaps, an unwarrantable one, although only applying to the principles of things, and not to things as they are; but on that account we may possibly find it none the less true.

We at least have been unable to perceive any necessity, and perhaps little sense or consistency, in the usual consideration that nature and the God of nature are separable existences; that is to say, that physics and the elements of physics are a subsequent existence evoked from *nothing* by an Omniscient Power, being in itself a perfect existence, and of whose nature physics forms no essential or inseparable constituent. Now, as respects the moral character or government of God, we are not at all inclined to canvass or question what may be his attributes or individuality irrespective of physics, or to what extent such independent existence may be possible. But in that department of his being with which we are physically associated, we must say that we can not possibly perceive wherein God, and all which formed physical nature, were separable, and as neither are subject to mutation, they must remain inseparable still; for if we inquire what must be the characteristic elements or attributes of either, we shall be unable to perceive wherein consists the difference. Surely no one will question that infinite *wisdom* is one of the highest and most essential attributes of Heaven, for in the councils of that high cabinet it is indispensable. On the other hand, every one will admit that infinite wisdom evinces itself in every department of the whole physical creation, which is in reality wisdom's most magnificent embodiment. Energy being the only means by which expression could be given, even to the counselings of a God, such must necessarily be one of his attributes. Again, this energy is everywhere evident as the only power which could give expression to physics; but this very energy of God and of nature would have been altogether without an object, or at least a physical nullity, had there been nothing against which it could have been directed.

We are altogether unable to perceive by what possibility or process energy could have originated any thing on which to exercise itself, for against a nonentity it could have had no power; but as it must have been equally essential to infinite wisdom and physical nature that it should have exercise, each must have an attribute in their primary nature that was neither involved in, nor could have been evolved from, wisdom or energy, either separate or associate. That important attribute we find in matter; matter without form, simple materiality. But possessing materiality even in its simple essence, we can be at no loss to perceive that energy would have an object to which it was applicable, affording at the same time a property on which the energetic attributes of God could exercise themselves, and a something from which the foundation and superstructure of the universe has been erected. Can we imagine any thing more as requisite, in constituting the perfect character of God, than his attributes of infinite wisdom, infinite power, infinite goodness united to omnipresence? Can we conceive any thing further as necessary for the development of the physical creation, or its constituent principles, than is infinite wisdom in the perfection of its structure, infinite energy in the execution of so perfect a devise, and an infinite principle everywhere ready to receive the energetic impress of wisdom's high behests? We must therefore consider, in a physical sense at least, materiality as an essential attribute both of God and nature, and the attribute of one as the elementary properties of the other, nature being but the reflex of its Omnipotent Originator, or, rather, the exercise of properties resident in him; for certainly there is nothing to be found in nature that has not its nativity in God. Here, therefore, the philosophy of the universe begins, the simple and sole elements of which are wisdom, energy, and matter.

It certainly will not be difficult to perceive the relation that must exist between mind and matter, for, being conscious that matter does exist, it must be either independent or associate; and if it were a fact that matter was a self-existing principle, altogether independent of mind, it would certainly seem surprising that it happened to be the very thing, and in the very condition and quantity, without which mind could not have effected the physical creation as it is. This certainly would make physical existence and the exercise of physical energy, by the wisdom of Omnipotence, to have depended on the presence, quantity, and condition of this very fortuitous self-existing something —a coincidence that is neither to be calculated upon nor conceived of. Every consideration which we can give this subject brings us more strongly to the conclusion that the material principle must have been a co-eternal associate of mind, and the powers of mind, and entirely at its disposal for the very purposes in the great scheme of nature to which it has been made subservient, as well as those to which it is still applicable; this being so, it is consequently coextensive with the power that imparts to it its action. The co extensibility of matter with mind may be a subject of difficult comprehension, for, so far as we know, it is a proposition never heretofore considered, because every one is constantly under the conviction that he can readily designate between matter and vacuity. Even the minds of physical investigators have been and still are much engaged in speculating or theorizing on the forces and functions by which matter is made to mix itself up with this supposed vacuity. The attractions, repulsions, polarities, and forces, active and latent, in electric and calorific conduct, which they have conceived to be the cause of the several conditions of matter in its varied associations and alternations with vacuity, so as to assume its variety of substances, characteristics of solidity, or etherealization, all these are, if we may not say absurd, at least surprising.

Men's minds are so made up with the idea of matter, as it is presented to or impressed upon their senses, that it is no wonder there should be so much difficulty in comprehending what in the abstract it really is. But as it is matter in the abstract with which we would now deal, we must forget that we have ever formed an idea of what matter *is*, as considered by itself, or was as a first principle of physics. We have signified this principle as coexistent with Omniscience, and if so, it must have been in all his ubiquity of character. This last is a most important consideration, one on which depends success in physical research; and that it may not be considered a gratuitous assumption, we have the proofs in the omniscient principle itself; for none will question the omnipresence of God, and that being granted, matter must be equally omnipresent, whether considered as an attribute or emanation; for to him it must belong in some manner—if as an attribute, his omnipresence would cover such attribute, so there could be no abrogation or omission in any point of the eternal expanse. For Omnipotence would not abrogate or annul part of himself, neither could he vacate the most minute portion of the universe of this attribute, by crowding or impacting matter upon matter, for it being impenetrable and everywhere equal, there would be no room for impact or condensation. Omnipresence would preclude either contraction or expansion, being without limit equally pervasive as diffuse.

Now, as there is only one other way in which matter could have come, and that is as an emanation or creation (should that term be preferable), the condition of things would not thereby have been in the least changed; for had that really been possible, from what part of the omniscient Omnipresence, we would ask, could this new principle have come? Why should any part of omnipotent extensibility have been more productive than another? this being the only existing power, and everywhere equal and alike. On such a Being, and at the beginning the only Being coextensive as he was with eternity, and no point of that eternity having more of his presence than another, it surely would be absurd to suppose a concentration of portions of himself upon himself, in order to give birth to material patches of a substance that was not in himself. He is certainly not to be regarded as an organic Being constituted of parts for partial conduct, and so having organs for generating jets of matter, for the making of bodies here and there, in kinds and qualities as occasion would seem to require.

It is surely time that philosophers should leave off investing nature with such a garb as their fantastic fancy finds a need, and permit her to be contemplated as evolving from the simple purity of her own native essences, which ever were, and are, and will be, in perpetual omnipresence. The attributes of the great First Cause, with their functions of physical development, being in all time, space, and eternity unchanged and unchangeable, could not possibly cause a thing contrary to their own character, or omit any thing for which their characters were qualified. How, then, could any portion of matter, however minute or extended, be created or emitted in the eternal regions of space without a like quantity being produced equally in all space, even to the occupancy of the most infinitesimal portions?

It certainly will be very obvious that from the God of nature there could have been no such creation or projection of any new principle, either limited or diffuse; for, he being everywhere present, *all* would still continue involved in himself, and be as before; so, on the same grounds, we can not possibly perceive how he could have created a new principle different from, out of, and apart from, himself, and any thing not being out of and different from himself, must necessarily have been in him, and associated with him as one of his constitutional attributes, and therefore no creation at all.

Proceeding, therefore, on the conviction thus derived, that matter has had a perpetual existence, or at least such a one as makes it equally pervasive of all space, how, it may be asked, is it now disposed of? that there should be so much space unoccupied, the vacuities being so extensive when compared with the material substances that seem to be so very remotely situated from each other as to induce the idea that space is the rule, to which matter is but the meager exception?

Now the real question of which we have undertaken the solution is not, what has become of all the matter? which we have demonstrated must have existed in every part of the eternal expanse (because nothing could have been made of that, there not being in the ever-continuous expanse a space in which to crowd a particle), but, rather, how it is that so much of it has ever been transformed into those conditions which we now recognize as materiality? for that in its primordial state must have been very far from being recognizable. Matter we have made out to be everlasting, indestructible, and subject to no mutation. How, therefore, has it ever become sensibly conditioned, as we find it?

This innate immutability of matter would certainly seem to be altogether incompatible with any transformation at all, much less into the infinity of forms, conditions, and substances by which it is now characterized. That we may obtain a knowledge of the process by which it has been conducted to these conditions, we must perfectly understand what it was as a primordial and abstract existence, and that will be attended with but little or no difficulty; for it is only to be considered simply and virtually as a *universal atom*, that is, an atom *infinitely repeated.* And why it could not be other than this atom must be very obvious, when we reflect that matter, as a simple thing, having no powers *per se*, would be utterly ineffective of any thing, and subject to the effect of nothing. For cohesibility having no attachment, each atom of all matter must have been but a simple and true mathematical point, respecting which the powers that are even now in nature would be unable to effect a reduction below that which would be thus consequent on the total absence of cohesive or affinitive force; for certainly no power in nature could ever undo, or have to undo, that which no power in nature had ever done. Or wherein can we conceive the reduction of matter to be more effectual than in the total absence of all power; for, in that case, there would be nothing by which it could have been held together, and such must it have been in its ultimate and abstract nature, as an element of physical existence, and before any forces attached thereunto. Thus reduced, every atom of matter in the universe would be of exactly the same character as every other atom.

For in matter, as a simple existence, there could have been no possible variety. Kinds, qualities, and conditions, being applicable to this simple element, as assumed by the philosophic world in general, is a monstrous and inexcusable consideration, which should not be entertained for one moment. Any argument here introduced in its refutation would be as much misplaced as the misdirected assumption itself, when applied to physical elements or physical progression; for the negative of this assumption, whatever difficulty it may cause in accounting for things, is certainly self-evident in the absurdity which surrounds it.

Now, therefore, agreeable to the existing and irrefutable rule, that one atom of matter is as every other atom, and that it is omnipresent, (when considered as infinitely multiplied), and altogether ineffective in itself, let us endeavor to ascertain by what measures any thing could have been made of it. We must at once perceive the necessity of something more than simple matter, which is entirely inefficient, but at the same time passively obedient to the power of will, therefore the most perfect thing conceivable against which to direct the energies of omnipotence; and henceforth it becomes the instrument of that power under the direction of such energy. It will now be for us to deduce the character and competency of such energy as could have made this universal principle of materiality effective of physical development, and this is only to be done by adhering to the same rigorous rule of deduction to which we have restricted our researches.

Hence, as we have defined simple matter to be but an atom in infinite repetition, passive and obedient to the energy of will, that will could only make application of its power to each single atom, that is, the atoms of matter in their respective individualities. When we contemplate the character and consistency of God, we find that what did not attach to the atoms of matter individually could not have attached to them collectively, or at all; and what attached to them as a first principle of force or action could not subsequently be detached; for he being immutable, could not take back or abrogate that which he had once been disposed to do; therefore any energetic attachment he may ever have applied to the atoms of matter, they must necessarily possess them in perpetuity; and it is this power as primarily applied to simple atoms that is now active in all forms, forces, and conditions, as we now find them presented to our senses; and this power as attached to the ultimate atoms of matter, is not only effective of present phenomena, but has been generative of every condition in the evolution of the physical universe in all the stupendous grandeur of its progression. What, then, must be thought of the wisdom that could have made such application of power among the respective atoms of matter, as must of necessity affect every physical condition in time and eternity?

The Omniscient Mind manifests its own presence so palpably in all the works of nature, by perfection of design and adaptation of parts, that the powers of observation must be imperfect indeed, and the reasoning thereon strangely perverted, if the mind does not acknowledge the whole to be directed by Infinite Intelligence.

We have seen what a simple thing matter was, and would have remained, had it been unassociated with, and unoperated upon, by any thing more effective than itself. We have seen its infinite susceptibility for receiving energetic impress, and we will soon see what a blind and profitless thing any kind of energy would have been, if undirected by wisdom that was infinite. We will find that the very foundation of physical nature is Omnipotent Mind, while the sole elements of her superstructure is matter in its passive simplicity, impressed with the energy of that mind in the beginning.

This *à priori* impregnation of the atoms of matter with formative force, causing birth and progressive development to physical nature, must have been both special and final; and without need of future emendations by either addition, subtraction, multiplication, or miraculous interference of any kind. For Immutability could not go back, advance, alter, or amend his own work, or have need so to do; as his wisdom was of sufficient scope to embrace eternity, and all that could transpire therein, he could have caused his impressions upon matter to be such as to accomplish this grand and mighty conception without reservation or revision. All conditions of the physical universe, or what is called the phenomena of nature, in all time or eternity, must have been in the immediate act of impress on abstract matter, following the infinite conception; for it is that which has worked its own way upward and onward, and which now presents nature as it is.

As the Almighty Mind everywhere operates by means (a necessity of his own nature, as nothing *can* operate alone), those means called into action at the beginning, and from which all others are derived, must be in him, and of his own immutable character; hence we find there can be no possible change in the absolute condition of matter, it being an indestructible and unalterable existence.

The material element therefore presents itself fully accredited as a principle *à priori* of physical nature; but in itself, as a simple thing, it must have ever remained utterly ineffective.

We must therefore find a *principle of action* characterized by a similar immutability; for this is the grand test or seal of office, which verifies the certainty of their mission; without which seal their credentials signify that they hold but a secondary or derivable tenure of office, which is at all times terminable; therefore by such mutability it becomes evident they could not have had their nativity directly in God. What therefore could have been the energetic attachments to the ultimate atoms of matter by which so much has been effected? What must have been these immutable powers that could have caused such mutability? Whatever we may find these principles to be, they must be subject to no change, and yet the rulers of every changing vicissitude.

Where in nature are they? If we look into the catalogues formed by physicists, we shall find mentioned many orders of forces, such as the attractive, repulsive, polarizing, chemical, electric, external, and internal forces. There are few phenomena in nature that some one or other of these forces in some of their grades are not made to account for. But however convenient this system may be, of assigning a force apportioned to every phenomena, and when one is not conveniently at hand to cover the difficulty, refer the matter immediately to God, still it is a system we are neither disposed nor directed by nature to follow. So we will endeavor to find whether any of these forces present themselves with the proper credentials which characterize their claims to office, at the board of physical commission, as involved in the omnipresence of God. When we apply our test of truth to these forces, we find that, with but one single exception, they are all marked with *mutability;* we find them active or quiescent by turns. Being generated by circumstances, they must cease their functions when secondary causes no longer elicit them; therefore they could have no hold of matter at the beginning, for if so, they would hold on through every vicissitude. Their activity at one period would be the measure of their force at every other period.

The only exception to the generally repudiating character of these assumed forces we find in the most simple and least pretending power among them, namely, the *Attraction of Gravitation.* This energy is the only one found acting equally on all occasions, and at all times, and under all circumstances and vicissitudes. In it there is no mutation. It is always equal to itself, and can be counted on as being that kind of force not originating in physics, but as the originator of physics, and the operative quality of that principle which could conceive, and by this execute the great physical scheme. This energy being of a primordial character, must have attached to the ultimate atoms of matter before they could have been made effective of any thing, and therefore at what we may well call the beginning.

Let us now endeavor to ascertain how it could have been attached, and in what quantities; for by this attachment the physical universe was fabricated. This is a very important consideration, and calls for very particular regard.

We shall not be able to say, with the philosophic world in general, as it respects this power, that every atom of matter in the universe attracts, and is attracted by, every other atom, which is to say, their attractions are mutual. We are altogether unable to perceive any wisdom there would be in such a distribution of power; and when we reflect that it was an omniscient Being who ordered this dispensation of power, we can not conceive he would have made his attachments so indiscriminately, for every atomic attachment necessarily involved the consideration of a universe.

It must have been by these attachments of energy to the atoms of matter that God virtually created the heavens and the earth; for, agreeable to his own nature, he could not have done it otherwise; and he being omnipresent, and in association with every atom, it need not have taken his omnipotent wisdom six days of any supposed length to have accomplished the proper application of power to the material principle. The universe was only to be evolved by activity, which had its root in the wisdom of his *will*, and its inception in the energy of that will; and they being everywhere with matter, could instantly make the impress. But had that (the impress) been equal, wisdom could not have been infinite; for this first act would have defeated his own design, as the consummation could have been but motionless sterility in the rigorous frigidity of death.

It mends not the case, that physicists find imaginary means to obviate the ill consequences of such an application of power. The very assumption of such forces implies an error of judgment in the very first act of that wisdom we all hold to be infinite; as if that wisdom acquired improvement by experience, and the God of nature could have done any thing requiring another act to correct it, or to counteract its tendencies.

Whatever wise men may say or think, nature never could have been reduced to such a dilemma—never could have been called on to institute counteracting agencies in the carrying on of her work, neither could she have admitted remedial agents for the emendation of her ways, as they could not be wrong. Had the material atoms been impressed with power (as stated by philosophers with respect to gravity), it would not have been long before the wheels of nature would have been brought to a dead lock; and so it would have been had there been counteracting agencies in any condition, for their conflictions would at some point have barred the possibility of progress. That this has not been done we plainly see, and *why*, need not be the cause of controversy, for nature herself could not possibly have adopted a plurality of forces as applicable to matter.

Of this we have positive proof in the fact, that two or more unassociated forces could not by any possibility have been made to attach to any *single* atom; for had there been room for two or more distinct adhesions, the attaching matter must have been susceptible of so many divisions, consequently could have been no simple atom.

It will, no doubt, be superfluous to remark, that the permanency of first principles must have been destroyed by attaching them to a divisible thing, subject at all times to tumble to pieces, as any aggregate of atoms would certainly be; and to a thing not so subject, it is certainly as useless to say, that as physical infinitesimals, the unit or root of all numbers and things could not have entertained any more than one ruling power as a perpetual law of their action; this law we know they do have in their attractive affinities for each other, which must be to the total exclusion of every other force or influence; but certainly not by such a perfect balance of reciprocity as philosophers assert, for there would have been no wisdom in thus making matter disobedient to the influence of Wisdom's will, with actions adverse to his own wise purposes, which would have been the case had more of it been impressed, or in any greater quantities or degrees than was strictly essential for the evolution of the objects for which the impressions were made.

All the phenomena of physical nature in the formation of a universe being altogether attributable to the energy attaching to the atoms of matter, made it highly essential that there should have been no error in its applications; and we know there could have been none; for Omnipotent Wisdom, embracing an omnipresence in an eternity of space, time, and physical progression, would certainly insure perfection in the act that was to evolve creation's widest range.

The omnipresence of this mighty intellect which could conceive the scheme of physics, having no especial sphere of action, but being everywhere alike, could operate from no center, as radiating physics from a focus, or evoking partial patches of activity at times and seasons, as nebulists with much apparent plausibility entertain themselves. It is evident when nature began anywhere, it must have begun everywhere, for the cause of such beginning being in the action of Omnipotent *will* in all its infinitude and energy which induced it, being an attribute of Almighty mind, and applicable at pleasure, it must have had a common but universal expression.

Should the idea be entertained that energy may have had its nativity in matter, and not in mind, it will be easy to correct it by the consideration that *matter*, as a simple existence, must have been in as much perfection without energy as with it; for it has not even now with all its effect changed the native character of an atom.

Not so with *wisdom*, for it could not have been omnipotent or in perfection had not energy been therewith associated and at command to execute its will, and that energy *not in* matter, but thereto transferable or attachable by the very influence of will. Thus we find the ultimate elements of physical nature projecting themselves in bold relief, with their outlines so well defined, that there need be no mistaking either the number or nature of elemental characteristics which really do constitute ultimate essences; and as they were at the beginning, so will they continue time without end, and continue without diminution or addition.

As the elements of nature are emanations or attributes of God, who can never retrograde, retrace, or deface his footsteps, we are enabled to find the first physical footprints of the Almighty, indicating themselves in their indelible impress on the ultimate atoms of matter, making those on which they fall to have attractive affinities for other simple atoms. Therefore, with their simple affinities, they must have been the only elements from which and by which the whole machinery of inorganic nature was manufactured. And all we have to do, or can do, in finding out how all this was brought about, is simply to observe rigorously the effect which this simple force of gravity would have upon the passive atoms of simple matter on which it was made to operate, and this, too, in total exclusion of every other assumed force or form of power.

Under the consideration, that energy is the peculiar and especial attribute of Omnipotent Mind, we must regard it as having been impressed upon atoms, with reference to the special ends for which such impressions were made; so that while every atom of matter was as every other atom, such could not have been the case with the energetic attachments, energy being the practical agent or operating force of mind, and consequently applicable at pleasure, having strict reference to its prospective effect in the evolution of physics as involved in that of mind.

The distribution of energy must therefore have been with such discrimination as would be most effectual in furtherance of the infinity of physical development, and being of but one tendency, discrimination could have only been in quantity and degree: the *quantity* with relation to the general whole, and the objects of which it was to be effective; in *degree*, with relation to atomic individuality, so far as they were to be effective of the different conditions of physical matter in constituting the phenomena of nature.

What Infinite Mind may have made of the immensity of metaphysical matter that is not thus taken into the physical account, is no part of our present inquiry, only so far as we may hereafter find its relation with existing phenomena.

That which was taken into the physical account, although now very much concentrated in the formation of suns and systems, must have been at first in infinite dispersion; and only so much affected in the sphere of each solar system as would ultimately aggregate itself into the several masses which now constitute their distinct members.

We can not be too strongly impressed with the consideration of the *infinity* of space (as we shall call it, for want of a better term), in which these attractively impressed atoms were diffused; and that their relative positions would have about as much to do with the phenomena that must follow, as would the measure of energy with which each atom was respectively affected, for such acting by a given rule as to distance would have required that positions, as well as impressions of power, should have occupied infinite consideration as to what would be consequent in such energetic application.

We now conceive that we have incontrovertibly demonstrated what must have been the nature of those simple elementary properties from which Infinite Wisdom formed the whole physical structure; for agreeable to his own nature from which they originated, nothing more could have been required, for they alone are of that character which could have been in him or of him. In contemplating the beginning, progress, and present condition of this vast universal structure, as induced under the wise direction of God, with what may seem such inadequate means, we must consider that while his wisdom was directing a suitable distribution of energy among the atoms of matter, it must have been in strict accordance with his infinite design; the application, therefore, as we have already observed, must, in relation to the whole, have been very inconsiderable; and so we see that the *greatest portion* still remains either almost or altogether unaffected. Now, however convenient it may be to call *this* vacuity, because it has not a *power* to oppose to the forces by which we are formed, or that can determine it to the formation of sensible substances, we may hereafter find it to be the very kind of materiality by which substances are made sensible; that is, the medium by which we are impressed with the sense of them as in sight.

Chapter Two.

Beginning of the Universe—Laws of Action—Aggregation of Atoms—Gravity—Center of Attraction—Spherical Forms—Secondary Bodies, their Adjustment—The Sun—Motions of the Planets, how determined—Composition of Forces—Jupiter—Introduction of Asteroids—Tides of the Ocean—Fluidity of Masses—Luminous Bodies—Gravitating Attraction, how applied.

IT will now be understood that when such quantity of matter as was requisite for the formation of physical and visible things was impressed with the required amount of energy, that very moment action and motion would thereby everywhere begin without limitation in boundless eternity, because this being the expression of infinite will must have been the whole will as thereby comprehended; for the atoms of matter so relatively and omnipresently affected would be unable to remain longer inactive. Thus it is that motion would have been the very first effect of energetic agency, and the commencement of all physical progress.

Now the self-same rule of law by which we so certainly deduce physical beginning not only does *not* refer to physical *termination*, but testifies conclusively *there can never be any;* for matter and gravitating energy being the elementary properties of all physical existence (and having their origin in that immutable Being who could conceive the full extent of physical perfection and development, and the means by which it was to be effected), must necessarily be as eternal and changeless as the being in which they are involved, and who first made one effective upon the other. Although the infinite mutability of physical phenomena may be effected by these simple existences, *they themselves*, or in their relations with each other, are changeless as eternity, or there could be no truth in nature.

It is now for us to find out how far phenomena could have been effected by these simple elements in the formation of a universe involved in an eternity of time and extent. If the great First Cause could by this particular means effect the formation of the universe, then, by rigorously refraining from all speculation, and confining our inquiries to the operations of these simple principles and their compound effects, we may possibly arrive at as correct a conception of the phenomena of nature, their causes, conditions, and relations, as the finite creature can be expected to acquire of the ways and doings of the Creator. It is by these agencies (matter and gravitation) the operations of nature are conducted, and we can comprehend them only by following out their effects. He who has contemplated the formation of a rain-drop or the construction of a hail-stone, and their fall to the ground, will readily comprehend what must have been the effect of gravity in aggregating matter into worlds from the midst of space, the affinity of molecular infinitesimals being the aggregating cause in either case. The gravitating affinity of atoms for each other would necessarily begin the process of their aggregating themselves round common centers; but the affected atoms being so infinitely minute, their relative positions comparatively remote from each other in the immensity in which they were dispersed, as well as their energy being of unequal order and active in every direction, by a given law from the centers of position, would certainly be much calculated to embarrass any hasty aggregation; for they could have been effected into motion only in so far as their relative powers and positions were not in perfect equipoise, for had that not been so, this balance of power would have obviated all motion.

All these circumstances considered, it is obvious that an incalculable extent of time would have been taken up in the aggregation of such atoms and globules as could have been even sensibly appreciable. The effect that such an infinity of these eternally disseminated centers of gravity could have upon each other will be more readily conceived than described; for in the complicated ratio of their numbers, powers, and distances, they must have been effected by each other's force, which we will not now undertake to define further than to say it must have tended constantly to their erection into temporary and miniature systems, whose common centers would as constantly compass their absorptions and recreations into other systems of enlarging capacity and powers. In virtue of such powers being constant and cumulative, this process of formation and coalescent conjunction would evidently proceed with a diminution of complexity and frequency proportional to their enlarging spheres of central action; and we may suppose with somewhat greater rapidity, as the several atoms and forms aggregated themselves and their forces, the augmentation of energy being equal and proportional to the aggregated quantity and power of the atoms concentrated in each confluent globule; and the sphere of their action becoming thereby less complex, these miniature systems would become more and more perfect, and their spheres of action of greater extent.

We may readily perceive, by this process, how it was that the very first effect of this most simple and single principle of activity began a system of motion and mutation that can never cease while the principle and recipient of action are changeless; for under the influence of this gravitating affinity, and the manner in which it was affected, there would necessarily be motions and revolutions of atoms, and aggregates of evanescent formation of miniature systems, constantly tending to coalescence and confluency around common centers, and their re-formations into other groups of circulating substances of equally evanescent forms and relative affinities. By this system of atoms and substances seeking to associate themselves with kindred substances, in virtue of a simple law of their action, we necessarily have their passing in successive gradation from a point to the most magnificent solar mass; through every grade of motion, mutation, and magnitude, comprehending existing suns and their circulating systems. It will be readily perceived that no such general and uniform condensation of etherealized matter as nebulists conceive of, could have been the effect of this single action, but that its effect would at once be the formation of sphericals and systems of sphericals, as much as that its final effect has been the formation of globular masses such as now form worlds, the affinity of atoms being the effective force in either case.

We will not now undertake to define (as it would be neither practicable nor expedient) all the actions and motions, relative magnitudes and positions, of the infinity of miniature systems, atoms, and aggregates circulating and seeking to satisfy their respective affinities throughout the immensity of space and comparative eternity of time that must have been occupied in this way, ere this simple gravitating energy could have effected the formation of globules so large as would have been comprehended by our sight; for we know not but there may be as many ultimate atoms in the formation of a perceptible particle as there are of such particles in the formation of a mass of solar magnitude, for what experience there is would even justify such an inference.

There may be much difficulty in giving sensible expression or consideration to a condition of matter so insensible as this, but when we contemplate that material conditions must occupy the immense interval between the physical condition of man and the metaphysical condition of his Maker, we shall perceive that such an assumption as this is neither to be looked upon as gratuitous or much removed from fact. When we consider every atom as an elementary part, not only of physical nature, but of physical nature's metaphysical Originator, by what computation can we expect to tell how many metaphysical atoms would make an appreciable particle? For this problem, we can safely assert, no man can find a solution; while to make calculation of how many measurable particles would make up the substance of a solar body, may be readily reckoned by any mathematician. We must calculate on an infinity of physical progression before it would have been possible for our finite powers to appreciate conditions or the conduct of substances; but as all is analogous with all, the affinitive forces being the same and constant, we can as well calculate the formative condition of the first constructed spherical as the last solar sphere; and the method by which matter was brought forward from the fathomless depths of infinitude, may perhaps be ascertained with as much certainty as if the whole had been subject to sensible inspection; for the gathering together of such matter as was effected by the gravitating energy, is such a simple and necessary result involving cause and effect, as can not fail to be perceptible and intelligible on the slightest consideration. Physical conduct, even to its very inception, may be much more readily ascertained than when in a more advanced stage of progression, because of the increasing intricacy of its combinations and consequent complexities; while at the very beginning there can be no difficulty in ascertaining what must have been the action of atoms when physically affected. And that physical matter, in its universal diffusion, must have been so discriminatively impressed with the principle of activity as to be separable into an infinity of spheres of immeasurable magnitudes, within which the active affinity of the matter contained in each several sphere would constitute for itself one grand center of convergence, to which all matter so relatively situated would necessarily but progressively gravitate, but most assuredly not in such a manner as those who entertain tne idea of nebulous condensations endeavor to make it appear; for they assume the whole as left for central action only, and their gradual condensations from the confines of solar spheres into their foci, or planetary spawnosities, or off-throwings expelled by force of centrifugal rotation, originated they know not how, and perpetuated by some assumed process of self-exciting action, of which it is inconvenient to conceive or discuss.

We must be aware, on the slightest reflection, that if the diffuse atoms occupying such solar space had attractive affinity to form one grand solar center, common to the whole, and to which they all tended in condensing convergence, they must at the same time have had affinities for each other, by which an infinity of minor formations must have speedily taken place, and continued while the general progress of aggregation was going on. The attractive equilibrium not being in perfect equipoise, they must have approached each other in virtue of this very inequality; for being thus permitted to exercise so much of their affinities in partiality, they would mutually move in that direction in which the combination of forces was felt most effectually, and by which they would continue to move and mutually approximate until contiguity would constitute their common center of combined action. This active affinity of each for each and all for all, in the infinity of their combinations and motal conduct, precludes the possibility of following them up in all the intricacies of their actions and motions, further than to say, as a general rule of formation, that proximate atoms would, necessarily for themselves, form common centers, to which they would fall in and flow around, forming spherical globules; this activity of matter would occupy all solar spaces to what we may call their confines.

The mutual relations of these first forms would at once resolve them into miniature systems, circulating round centers common to each group, but constantly undergoing change by absorption of atoms, and even their own members, as well as in the formation of new and enlarged alliances and relationships with other forms, other atoms, and other systems, these very first forms, systems, and family associations being a perfect type of all the transitory systems that must have intervened, in the grand order of progression, between the first sphericals and the final formation of solar groups, into which all has been aggregated.

Simple gravity would most assuredly be effective of such system-forming and center-seeking processes in all their variety of memberships and modes of motion, by paths rectilinear, curvilinear, or convoluted, which must have been prevalent among the matter of each grand and general sphere of action, while all was converging to that solar focus or mass into which they have been merged. This original formation of systems and combinations of systems which must have occupied each solar expanse with their forms of motion and spheres of action, must necessarily have continued to grow and expand, by an infinite series of collapse and reconstruction, until all physical matter was gathered up in massive aggregates no longer subject to coalescence. And as atoms pursue precisely the same rule of action now as at *first*, forms and systems are merely at this time on a more magnificent scale, and the corresponding forces by which they are now directed is but the simple effect of their concentration and combination.

We have the most beautiful exemplification of how matter must have been aggregated in the formation of miniature worlds in the aqueous matter of our atmosphere, or any other liquid substance in their condensations from a gaseous state. When left to the free exercise of their own attractive action, we find spherical globules to be the first visible forms their particles take, and which they continue by coalescence and confluency with others until they attain the bulk of larger sized rain-drops, and often much larger hail-stones. Now how could physical matter, when disseminated in solar space and subject to the same rule of conduct and contiguity, and with much less restraint, have done otherwise than this, when free to the continued exercise of its own formative affinities, while the formation of rain-drops was subject to a rapid fall through the atmosphere?

The very atomic force which aggregated first forms, still continues all aggregations, of whatever sort, and is the only power which could have caused all the aggregations of substances, formations, and transitions of systems, from the beginning of motion and magnitude to the final formation of existing masses of solar and secondary character, and their mighty mechanisms around their several centers of gravity. When we consider the infinity of antagonisms and retardations to central aggregations, as operating in adverse attractions from surrounding solar spaces upon the matter seeking a common center in this, and from the inconceivable quantity of forming substances disseminated in its own solar space, and that must have been more or less interspersed therein during the whole process of the aggregation of their matter into existing central masses, we shall not be able to resist the conclusion that the length of time taken for the convergence of such masses must have been inconceivably long, for it will readily be perceived that the aggregating processes could have progressed but slowly, for had force been equal to force, or had the attractive complement of all with all been equal, matter would, by the balance of power, have remained forever at rest. In the combination of forces, therefore, which must have prevailed in solar spaces, motions and aggregations could only have been conducted by the attractive forces which were in excess. Substances must have met substances among surrounding attractions, in patches where that energy was most effective, and while all were converging to one common center.

In this review of the effective operations of gravitating impress upon the simple atoms of matter, we thus far have no difficulty in perceiving the condition of things to have been the gathering together of solar matter into central masses, after having passed through an infinity of coalescent aggregations, sensuous motions, and systematic relations of longer or shorter duration, such as we have already considered, and such as will be evident from the free exercise of this force.

It may now be well to inquire by what conduct of gravity solar bodies could have been made to occupy their present relative positions in the eternity of space, and how it is they themselves have not been equally enrolled in one universal vortex of convergence; as other systems formed within the sphere of their action have either been swallowed in, or made to circulate round them. Against this contingency philosophers have long sought for the provision, believing it essential to the stability of things, that all should revolve round the common center of all.

Thus a belief in one grand and universal center has long been prevalent; but that belief is no proof of such an existence; indeed, the very assumption of a center implies a circumference, a consideration neither philosophical nor rational; on the contrary, it is an absurdity to suppose either, for from whence could an eternal continuance converge? or round what point of space could an interminable creation revolve? This very idea of a common center necessarily involves the idea of a common circumference, which again implies a limit both to nature and to the God of nature—all which is absurd.

Philosophers and astronomers may continue to speculate or explore and improve their powers of space, penetrating vision "to the crack of doom," but they will never be able to descry that long-contemplated and sought-for *center* which their laws of motion make so essential to the preservation of physical existence—that force round which all nature would converge, only for the centrifugal or projectile effect of what they assume to be the first law of motion. Now we should suppose that all such fears would at once be dissipated by the consideration that there can be no convergence from any confines there can be to the eternal continuance of created things, therefore no necessity for any provision against a universal collapse, by making all the members of this infinitely extended family keep open order by virtue of their motion and centrifugal momentum, as induced by motion's first law. If philosophers really knew what was motion's first and only law, they would be aware that it was but a making up of the unsatisfied balances by which all is sustained by all.

We shall find that the simple affinity of atom for atom, operating in an interminable universe of matter, would in itself obviate the necessity for any provision against a collapse, and likewise do away the necessity of a general center around which the universe should revolve. And there is no doubt but we shall find it will equally obviate the necessity of what is called the first law of motion; for if there is a faculty in matter for motion, it must be induced by the gravitating power, there being no faculty inducing power in nature but this.

The physical matter of the whole universe being so attractively affected as to be divisible by the inequality of its own balance of power, it must have of itself separated on the confines of the solar spheres, that is, where the attraction of each for each were equally balanced, so that within the circumference of each solar sphere's aggregate action, tending to some general center as common to the whole (but exercising in the mean time its more immediate affinities in the formation of minor systems), there must have been bodies formed somewhat in the manner already considered, but ultimately coalescing in the solar substances. These concentrations of matter around their respective foci of power are certainly far from being seclusions from each other's attractive affinities, or reliefs from their eternal relationships; therefore all being still operative upon all, would necessarily regulate the relative position of each to each.

We can have no better exemplification of how the attractive forces affected the positions of the fixed stars, than by supposing a vast hollow sphere with attractive pencils penetrating from every point of its internal surface, and taking effect upon internal matter supposed to be disseminated therein. It must be evident in such a case that internal matter would not be drawn to any one point of the internal surface, because the combination of forces from every other quarter would determine against the attraction to such point; so that any particle, in place of falling to any part of this internal surface, would retreat therefrom, because of the combined attractions being most on that side of the particle toward which the center of the sphere was situated. Whatever floating matter might be included in this sphere, none of it could possibly settle on its sides; and whatever effect their own formative affinities might have upon each other, they would constantly converge to, and ultimately coalesce in, the very center of each sphere, or on that point of the spherical expanse where the attractive pencils would intersect each other in equilibria. Such would certainly be the effect of an attractive sphere of whatever magnitude we may assume it to be, provided no other attractions affected it besides those connected with itself and its internal matter.

Now we should have exactly such a sphere, provided our own globe was hollow to any very considerable extent in the center; for, suppose this were really the case, every one must be aware that a substance let fall into this cavity would descend, not to the internal sides, but to the central vacuity, and occupy the place where the earth's center of gravity now is, and there it would continue suspended in virtue of equality in the surrounding attractions. And if forced from this position by any impulsion, it would soon regain, by oscillations over the center, its former position in it. Were the condition of our earth as thus assumed, any substance not forcibly attached to its inner surface could not remain on that surface one moment, no more than detached substances can rise from its external surface, for it would fall away to the center common to the whole mass. The common center of gravity for the whole mass being the only point at which gravity would be satisfied, and that point every atom would occupy, were it left to the freedom of its own election. The center of our earth being really so vacated of solid matter, and occupied by diffuse interspersion of invisible particles or atoms, we should have a perfect repetition, on a small scale, of the manner in which solar matter was aggregated in the spheres, of which they now occupy the centers. Its condensation, consequent on its own attractive affinity, would necessarily follow in the form of a shower of spherical globules falling toward the center, and forming in their descent miniature systems of mutual association, such as those of which we have already spoken.

This center-urging influence of gravity we find reproduced in every aggregate, from the first-formed spherical to the masses and mechanisms of systems and magnitude of solar associations, for thus it is the suns are fixed in the firmament on high; for solar positions in the eternal expanse are only to be considered as centers to the spherical vaults of "heaven's high archings." These solar spheres of immeasurable magnitudes are pierced at every point by attractive pencils passing in infinite interchange among the matter that makes the universe. Therefore there must be such centers, at which these attractions of surrounding systems infinitely repeated intersect each other in equilibrio; such centers are, without question, the only spots in space at which any substance could be at rest in its relations, each being acted on by all around as if it were the sole center of the universe; and so they virtually are, when we consider them infinitely repeated. Were it possible for any of these substances to be disturbed from their positions, the forces of their fellowship would as certainly restore them to their places, as our earth would determine the sustenance of a substance at her center of gravity; for the same rule that regulates the structure of a dew-drop determines the character of every motion, substance, or system; so that in the physical universe all is analogical with all, and every thing deducible from every thing, as the severalities of an eternal unity. Now, while the consideration of the divisibility of all space into spheres of central action holds good, as a universal rule, such must not be supposed to imply that each sphere is of equal dimensions, or that they individually contain in their centers substances of solar or any other magnitude; for there may be, and unquestionably are (as observation will testify in the complicated machinery of heaven), many compound spheres of solar action as well as of planetary and secondary association, embracing double, triple, quadruple, and even, it may be, constellations of solar bodies, circulating round common centers of varied combinations in their own proper motion; and in virtue of the same motal law of atomic affinity, but certainly without reference to any great universal center, or any rule of initial impulsion, While such have centers around which they revolve, still they are no more to be considered as centers common to the whole universe than is the common center of our solar system. So far as we have yet pursued the physical process, we have certainly much reason to be satisfied that all aggregation of forms, convergence of systems, combinations of solar associations, with all their motions, their miniature and magnificent relations, from the initial atoms until now, have been effected, upheld, and sustained by the simple affinity alone which one atom of physical matter has for another. Nature having the credit of being a great economist, we are not to suppose that she employs a plurality of forces where we can find that one would have been equally effective.

Our observations thus far having had reference more particularly to solar substances, their concatenations and effects upon each other, exclusive of the consideration of planets and their satellites, it will now be for us to inquire by what process they have been produced, or how it was that the affinity of atom for atom did not all operate in the more general condensation of solar substances? Or why there were exceptions to this general rule in favor of the production of secondary bodies, their relative positions, and modes of motion? For we must observe, had these vast solar spheres, already considered, been wholly vacated of their diffuse matter by central action and solar aggregation, there could have existed no substances but those of a solar character; for, in that case, from whence could secondary bodies have come? Or by what could their positions and motions have been determined, there being nothing from which either could have been constructed? They can not surely be considered as outlying substances and systems that were embraced in the circumstances of solar convergence, but had been arrested in their central-seeking passage; for in such a case what could have been the cause of their arrest? Or what rule could have regulated their present positions, relations, and motions, while all else was ingulfed in the grand vortices of massive aggregations, which make up the solar bodies.

These relative conditions and positions must have been consequent on some cause that yet remains to be accounted for, and the question is narrowed down to the very circumscribed consideration of the circumstances under which gravity could have been effective of planetary productions at all, each solar sphere in the eternal subdivision being occupied by a common center to which its contained matter would converge, and with which most of it would coalesce, how came these planets and their satellites to be an exception, gravity being the ruling force in shaping matter in all its phases? Circumstances must in this case have ruled the exception, and they will readily be found on a reconsideration of the general divisibility of physical matter into solar sphericites. For in the immeasurably remote regions of space, and intermediate of the several spheres of solar effectivity, there would be vast expansions of diffuse matter, which (being so far from central forces, and where their influences being equal and neutralicant of each other, could have but little or no effect on matter in such regions, and particularly on the intermediate line of attractive equability) would, necessarily, by local affinity, be converged into a multitude of comparatively isolated masses, and these aggregatiag bodies being sustained in their places by the attractive equability intermediate of solar influences, they would aggregate the surrounding matter that was within their own independent spheres of action, in the same manner which we have seen solar matter was aggregated, and there these massive bodies would remain until disturbed from their places by some subsequent force.

It will be perceived that such systems of formation are not at all imaginary, but what must really have been the inevitable consequence of the attractive diffusibility on an eternal dispersion of ultimate atoms, as there could have been little or no disposition in the matter thus situated to part from its position in obedience to the common attractions of the great solar spheres, because the attractions of these would here have been equalized. Thus vast regions of outspread matter would have been left at liberty to enter into such aggregations as we have already contemplated for solar matter, but without any immediate tendency to these common centers. Such bodies during their general aggregations would necessarily have been situated intermediate of the solar attractions or equability of forces. Now as these solar centers would necessarily absorb all matter that had any immediate tendency to them at the beginning, so these intermediate aggregates would ultimately absorb all matter which conflicting solar forces had left at liberty to form common and independent centers for themselves. Thus we perceive that existing masses, whether primary or secondary, when in their native positions and primary conditions could have had no permanently existing bodies circulating round them, for, as we shall find, circumstances were not yet such as that simple attraction could have sustained any such condition of things.

Existing masses, therefore, while in their native positions must have absorbed all matter or material forms within the sphere of their constantly increasing influence, so we may look upon them all as exercising isolated action in their individual aggregation. We may likewise calculate with confidence that on the vast verges or confines of solar spheres, intermediate of their concentrating actions, there must have been immense scope for such secondary formations; and that the attractive affinity of contiguous or approximate matter must have been there more effective for the production of secondary and independent centers than it could have been for solar substances. These, therefore, would constitute the exceptions to the general rule of solar absorption. These cutlyers (as geologists would say of their isolated masses of rock), being so immensely remote from the major influences, as well as that of each other, would necessarily be the most favorably situated for attracting to their gravitating centers most of such matter as may have been left in the general condensation of the central masses, and their several magnitudes would be more or less proportional to the extent over which their respective attractions were predominant.

In the universal centralization of physical matter which the affinity of atom for atom would necessarily induce, we find the order of its tendencies to have been the resolution of spheres of activity corresponding in extent with the condition of things as they immediately were in all the gradations, from an atom to the most magnificent orders as they now exist. Matter in this transition passage must necessarily have undergone infinite modification in its series of systems and associations, by their constantly enlarging themselves and their spheres of action by the repeated absorption of their constituent members in centers common thereto. These again, in their turn, would constitute one of another and different class of relations and enlargements, to be again amassed in one general whole as before. Nor would this transformation of systems cease until all matter was so situated that the resolution of its forces could effect no further transition. This tendency of atoms, substances, and systems to ultimate centers, of primary or secondary import, must have been characterized by similar conduct in each.

The immeasurable extent of both time and space that must have been occupied by matter most remote from its ultimate centers, and before its incipient motions, contending against exterior and conflicting attractions, could have passed through all its formative phases and reached the realms of its final destiny, would certainly have given bodies ample opportunity to pass, by a series of association, through their relations, in perfecting to a very considerable extent the aggregation, not only of primary masses, but likewise of planetary and secondary bodies, which now circulate in the great solar spheres to which they respectively belong.

While we have so certainly perceived the perfect efficiency of that attractive force by which atom has been drawn to atom in the general aggregation of matter into existing masses from the wide-spread universe, we can not forego the reflection that such efficiency could neither have been casual nor self-constituted, as we can not perceive how any *fortuitous* application of the attractive energy to the atoms of matter could have eventuated in the magnificent orders that now exist. Had the application of energy been otherwise than what it was, the order of nature could not be what it now is; and we have found that, in its transition state, it must have passed, by a progression of transitory systems, to its present condition, at any stage of which physical operations may have been final; for a universal order of nature in all its systematic relations could have been as well sustained in perpetuity by the balancing effect of attractive affinities on systems whose constituent members were not larger than molecules or marbles, as it could be by the present stupendous masses with all their complicated motions. It would only have required that the relations of masses and distances should have been preserved in their corresponding relations, to have perfected a consummation of the aggregating process at any of its periods of progressive enlargement. Something more, therefore, than a fortuitous affecting of the atoms of matter, with the gravitating energy, must have directed aggregation to its existing conditions, which renders it impossible to resist the conviction that all must have been the exercise of infinite forethought in the disposition of energy among primary atoms.

We assume that by this time there is satisfaction with respect to the aggregating abilities of the attractive energy, and having thus found the simple but effectual method by which all physical matter must have been concentrated from the profundities of space into an infinity of masses of various magnitudes, it now remains for us to define the process by which it could have caused the approximation of such bodies to each other, and yet have preserved them from coalescence, or how it has resolved the revolutions (particularly of those masses which encircle our sun) and the attendant satellites which circulate round them. We must find in this attractive effect the reason that their revolutions should so generally approximate one plane, or all revolve and rotate in the same direction; or by what principle of this simple action it can be that these motions are perpetuated.

These are certainly considerations of great physical import, for they embrace the whole mechanism of the universe, its motal powers, and the measures of action by which it has been effected, and is now sustained. We shall have but little difficulty in finding that all this is not only attributable to, but necessarily consequent on, the simple affection that one atom has for another; a power with but little pretension, certainly, but still the only one, we may say, which renders Omniscience physically omnipotent, it being all the force found requisite in constructing the physical framework of heaven. We have contemplated its conduct among universal matter, and found its constructions to have been in masses of a primary and secondary character, in consequence of their different native positions. Now, had they retained such positions in perpetuity, it is not difficult to perceive that they would have been profitless productions, and our sun could have had neither planets nor satellites. But as that could have been no part of the Omnipotent plan, it must have been otherwise ordered in his agencies; and we now perceive that matter could not have been so charged with affinitive action, or its present conditions would not be so different. At the imposition of the attractive impress it must have been so ordered that secondary bodies, at suitable periods, should be subject to be disturbed in their native positions by some infraction of the equability of the forces by which they had been sustained during aggregation; for had it not been so, their places would have been a perpetuation, so that every individual body in space would have forever occupied its own isolated position, instead of becoming a member of one of those planetary associations which encircle suns.

It would be impossible to conceive a condition of forces or of forms of action among the complex attractions of material substances by which secondary bodies in their intermediate positions could have been permanently sustained while universal matter was making up its balances; for, until all the places of all the bodies were adjusted, the positions of none could have been permanently located or secure. For so nice must be the balance of universal relations, that were our solar system now annihilated, the eternal universe would be forced to a readjustment of its balances that would radiate onward forever; for universal matter, as attracted, has worked out a universal adjustment of place for its masses with its compensatory balances; but were our solar sphere annihilated, there would be nothing in space or time that could compensate or satisfy a disturbed relation to which there is no end; therefore the readjustment of this disturbance would go forward in the realms of space forever, but while all was determining the balances of all, all could be balanced by their compensatory equivalents permanently. But this general disturbance would not have followed the simple change of place of any secondary bodies in the general adjustment of matter, for then it was that each was urged by each, and all by all, to their final position in arranging the great balance-sheet of nature, which was so essential for the perpetuation of the universe. The grand solar centers and substances by which all materiality was divided into perpetual sphericities could never have been to any considerable extent disturbed in their relations or native positions; but not so with secondary bodies, for however favorable situations may have been for their inception and progressive aggregation, being intermediate of major and mightier influences, and by them for a time sustained, the smallest infraction of equability could never be compensated, and their subsequent tendency would inevitably be in the direction of that solar force which had thus obtained an ascendancy over them, and by which they would be made to penetrate the solar sphere into which this force conducted. We thus see how secondary bodies so situated would have been forced from their uncertain and precarious spheres of formation into those more permanent ones for which they were designed. Now it will be perceived that a body situated among a combination of complex attractions by which it had been equally balanced, could only propagate its descent in a line perpendicular to the point where the forces were most effective; the ratio of speed being at all times equal to the preponderance of force in that direction, consequently we can not see how the rule usually said to regulate force and motion could possibly be made to apply to a body actuated by such an infinity of conflicting attractions, radiating from every point of space, and to the influence of which every mass must be more or less subject; while to moving masses it would be modified at every point of their changing position.

In the composition of forces that could have effected any considerable degree of permanency to an aggregating body in intermediate space, there could have been but one possibility by which its disturbance from that position could have made it descend perpendicularly to any solar center, and that would be by the perfect equability of all surrounding attractions in favor of that particular direction, a circumstance that could not be more than barely possible; for by the resolution of forces, there must have been an infinity of chances that disturbed bodies could not have descended by this perpendicular path; for, while every other body in space was exercising an attractive influence over them, as well as the one into whose more particular sphere they had entered, by the effect of these forces, they would have been made to descend by such inclinations as predominant powers should determine.

It certainly requires but little consideration to arrive at the conviction, that any intermediate masses which may have been aggregated in the focal equilibrias of a combination of solar forces having been made to depart by however little from their central positions, that little they could never thereafter recover, and would be likely to be made to determine in favor of *more than one* of these central forces. In such a case their paths could not have been directly to either, or in any other tangentile line whatever, but somewhere intermediate as these constantly varying forces might determine. And did they ever reach the centers of the spheres in which their motions were induced, it would necessarily be by paths of convoluted curvature, this being the only possible way in which bodies could make progress in space subject to such conflicting attractions, there being no tangentile line that they would be allowed to follow. Now there can be no difficulty in perceiving how this principle would operate in the introduction of our planets and secondary bodies into our solar system, they circulating round both solar and planetary centers. Let us assume the greatest portion of the planet Neptune's mass to have been aggregated somewhere on that curve which makes the confines of our system's superior convexity, and that it was the first planetary mass made to feel this superiority. We certainly must know that when that mass lost the equability of its native position (wherever that may have been), it must have merged within the confines of our solar force, for to our sun must have been given the ascendancy over all other forces, or it would never have been brought to circulate round his body. But we must be likewise aware, that if other lateral forces had not affected that body in the propagation of its motion onward, it must have descended directly to the sun and impinged on his mass. Therefore the conclusion is obvious, that it was by the composition of solar forces that the body of Neptune, as it penerated our sphere, was made to incline so much from a perpendicular to our system's center. The first angles formed by this body's path to a solar perpendicular, or to the circumferent sweep of our sphere's vast curve, would necessarily be determined as the resultant of predominating attractions internal or external of such bounding ability. This body thus put in motion in obedience to these superior influences, the force of all its innate affinities would be brought into action in the exercise of constantly changing relations, and in sustaining the direction and motion last generated, as a tangentile projection, but which the predominating power of our solar attraction would as constantly restrain by an infinite repetition of falls from such tangent. The initial momentum acquired by a tendency toward the predominating forces, internal and external, would necessarily have urged the mass onward past those approved rays of external attraction, by whose associate influence it had been urged forward, and the infinity of exterior attractions which must have pierced our solar sphere at every point, and to whose action this moving mass must have been responsive, would (with its own centrifugal momentum increasing in the direct ratio of its approach to the central attraction, or otherwise in the direct effect of its excess of fall from a tangent in equal times), really constitute elements of any curve in planetary orbits, and would necessarily sustain a planet in its orbitual circuit round the common center of the sphere in which its motion was generated.

The angular position in which a combination of forces would let fall bodies from space would necessarily determine these curves of motion and their distances from the solar center; for, as we have seen, were they to penetrate our sphere perpendicularly they would ultimately impinge upon that center. But when we contemplate the vast dimensions of this solar sphere, and the infinity of angles at which it could have entered, and the number of forces by which bodies are affected, they may have penetrated at any conceivable inclination; and the more remote from the sun a planetary body is situated, the more proof there is that external forces must have had much to do in directing its fall from its native position, and the less will be its fall from a tangent to its orbit in any given period of time, and consequently less will be its tangentile velocity. But, at the same time, the greater the power of exterior attractions which are compensatory, inasmuch as by their distant situations they are as much within the rules of preservation as any other; for, on the other hand, the nearer a body is to the common center of gravity, the greater will be its fall from a tangent to its orbit in every second, and consequently the greater its tangentile velocity, which would again compensate for the diminution of exterior attractions, so that its position would be sustained by the force of these active relations, at whatever angle it may have entered solar space. In a word, planetary bodies are all admirably sustained in their relative positions and motions (with the exception of their influence on each other, and that, too, is compensatory) by a combination of exterior, interior, and tangentile forces, to which planetary masses were compelled to adjust themselves.

Were the planet Neptune now to widen his circuit, his fall from a tangent thereto would not be as much as it now is; his motion by its diminution in the same ratio, giving the solar attraction more time to operate, would exactly compensate for the increase of exterior attractions; and, on the same principle, were the earth to contract her annual curve, the fall from a tangent to that new orbit would be proportionally greater in every second of time in consequence of the sun's increased attraction, which would cause a corresponding acceleration of tangentile velocity, which would again compensate for the diminution of exterior attraction (caused by increased distance). Thus it will be conceived that planetary bodies could, under no circumstances, either fly off at a tangent or fall to the common center in paths of convoluted curvature while the combination of forces that now conduct their motions continue to be effective, and, as we have already seen, such will continue so long as atomic energy remains unabrogated and which we have found to be in perpetuity.

Now can any thing be more simple and satisfactory than that which flows so freely and certainly from the simple circumstance of every simple atom having been impressed with attractive affinity for every other atom. The primordial application of this force we find to have been the sole determining principle of all that we have yet considered or attempted to explain; and whatever opinion may exist with respect to the origin of masses, or resolution of motions or forces by which they have been effected and perpetuated, there can be no controversion of the fact that external forces must have had, and still have, much effect upon internal actions. Our system's central force, however powerful it may appear to us, must be but a small circumstance when compared with the attractive fields of infinity. The incalculable distances by which substances are separated in the boundless realms of space, and the estimated rate of gravitating diminution, are too well calculated to induce the idea that the extent of its power is in all instances circumscribed within comparatively inconsiderable limit, perhaps not extending to or beyond the confines of our sphere's superior expression. When we find it stated as a primary law of this force, that its diminution is as the square of the distance, we are altogether unable to perceive how this could apply as a general principle; its application to isolated bodies, and all that immediately belong to them, may be unexceptionable as far as local calculations are concerned. But it is certainly absurd to suppose it susceptible of being carried out, as a general principle or law of universal force, with unity of action. The central power of our system being but one of an infinity equally radiant of the attractive rays, each sovereign center in this grand confederation of realms must have a spherical space assigned for its special supremacy, and while these independent sovereignties are so exclusive that no subject can escape from or intrude on another, all must still be effective upon all in this universal confederation for the safety and good government of the whole; for although between one and the other there are intermediate barriers over which no body can pass, and where force meets force in equal measure, and however ineffectual such forces would *there* be on any substance as respects motion, which we have already seen with respect to secondary masses, this is not to be considered as an extinguishment of force at that particular bourne. From our system's central influence to its external influences, central attraction must have been so modified that every intermediate body must necessarily be acted on in the increase ratio of the square of the distance; because *beyond* that limit our system's force could no longer be effective over others, while *within* that limit it can only be effective for motion in the measure of its sensible expression understood as ponderosity, for on the line of that limit the opposing forces of the several solar systems neutralize each other's effects.

The very position of our system's center with respect to others is the best proof of the prevalence of exterior attractions, for at our system's center, as well as at the circumference of solar spheres, force must meet force in equal interposing relation at those points of intersection for solar position, for these forces are ineffective, but not extinguished. However neutralent or modifying the effect of force with force may be at all times (as there can be no collision between adverse *attractions* as there are between adverse *substances* attracted or in motion), they can have no extinguishing qualifications. Therefore the diminution of this power by the inverse square of distance, however well it may answer as a measure of the excess by which any body is actuated, with repect to the whole, it is certainly no measure of the space over which it may make its way with its modifying effect upon other forces. It is usually supposed that light radiates by the same rule of diminution; but we shall not fail to find its ray affecting the smallest eye of the smallest insect, although to do so it is known to have penerated, when most remote, an extent of space far transcending our powers of conception, and there are no indications that rays meeting from adverse quarters either affect the passage of or extinguish each other's luminosity. The compositions of attractive forces on this universal principle are necessarily complex, and so continually varying, that the same force can not affect equally any two points of space, therefore no definite calculation can be made only as respects their sensibly effective operations upon sensible substances; but this we have found to be so simple and self-evident as to amount to a positive demonstration, for we have irrefragably deduced from these attractive combinations that the force of the moment must be at all times equal to the velocity of the moment, not by initial impulsion and the native inertia of matter, as philosophers inform us, but by the repetition of force afforded by universal attraction.

This system of simple unity of action has a vast superiority over that which supposes a special and final *impetus* as an initial and perpetual law of motion, which makes it essential that space must be in every respect free for its exercise, or otherwise there could be no perpetuation to our solar system as it now is, for any species of retardation, however slight, would ultimately eventuate in this initial motion's total extinguishment.

Philosophers have even feared on this account for the permanency of planetary motion, they having discovered or suspected that there is in planetary space a medium to some certain extent retardatory of the passage of some certain comet, the effects of which they have laboriously calculated as to ascertain how long it may possibly be before it so contracts our earth's orbit as to make her a part of the solar mass, or to bring us in such proximity with that body as that its effects would be destructively inconvenient.

Now, while there is truth in nature, we may safely conclude that there never could or can be any such a contingency, for nature is always equal with her forces to effect the conservation of her measures that are caused for good, without having recourse to special or extraordinary expedients or a reconstruction of worlds thus wound up in coalescent convergence. And, in the first place, it surely requires but little reflection to find that since physical nature began, there could have been no possibility for the existence of such a prerequisite to this erroneously assumed order of motal law as free space, because of the universe being preoccupied with a system of attractive forces differently effective in different positions, against which no initial force could have successfully contended. And, in the second place, it being agreeable to nature's law that there should be a medium of retardation in planetary space, they can as permanently adjust themselves to such a condition as if it did not exist.

Let us suppose, for example, that this resisting medium is as stated, and that it were at once suddenly doubled in our earth's orbitual path, the effect would be simply a contraction of her orbit in a corresponding degree to this obstruction, which would in an equally corresponding ratio increase her tangentile speed until its force was precisely compensatory, causing no other difference save that of a shorter year by this certain degree of solar approximation. Were our solar system isolated from all external influence, as the rate of gravitating bodies as they are usually estimated would seem to imply, there would in that case be a requisition for the philosopher's "first law of motion," or matter would have been wound up, for, however absurd it may be to suppose self-sustaining energy as an innate quality in matter, independent of the attractive affinity of atoms, it is certainly essential to such an assumed system of philosophy as this. And whether this supposed force is called the inertia or vice-inertia, we are not the less at a loss how it can be conceived of at all as a motion impelling and perpetuating power. Simple matter must, no doubt, have been infinitely inert, but not by any means in the sense in which it is usually conceived to be, for inertial momentum certainly means a positive quality, or how could it continue the momentum of such ponderous masses as the planets? the inertia of matter can only be properly considered in the negative sense as being at the same time infinitely passive. Infinite inertia and infinite passiveness are necessarily associate and compatible qualities of negative character which must have belonged to simple or metaphysical matter, but infinitely ill qualified to give momentum. This erroneous law of inertial motion and inertial force would necessarily originate another and kindred proposition, which all nature proves to be preposterous, that is, "that motion is as much the condition of matter as rest." This, although received in the scientific world as an axiom or elementary principle, on which their whole system of motal law is based, can only be so in support of a false proposition precedent; for about what, we would ask, has all the energy of nature been employed from the beginning of time until now, but to counteract the innate or apathetic immobility of matter?

This very action is in reality the vital principle of nature herself, without which all would be lifeless and motionless as the physical nonentity which preceded her inception. The motion of the spheres therefore must be as much an expressive measure of repeated forces as that which regulates the tides of the ocean or the spherical rotundity of its waters. And should there be nothing in all this to show the absurdity of the usually assumed system of motal economy, we have still further proofs of it in the action of what is held to be the second law of motion; for we can not possibly see *how* it could perpetuate a partnership of such irrefragable delicacy as to maintain a balance of power with the first or inertial law. This second law, acting from the system's common center, is said, by its attractive force, to bend the initial or rectilineal motion of planetary bodies into the curve they describe round this common center, and is supposed to take effect on these bodies without being any restraint on their forward motion, because, as it is assumed, the common central attraction acting at all times at right angles to the planet's path, forces the infinity of repetitions from a tangent, which are the elements of these orbits, without affecting in the least their initial velocity. Now this certainly is another very erroneous inference, likewise originating as an essential attribute in carrying out the first misconception. The idea of a projectile being thus continually bent down by a force, without that force being any restraint to its forward motion, is certainly too far-fetched and inconsiderately received to be available in the support of any hypothetical doctrines when its credibility is fully tested. The common center of gravity for the system, as it is said, bends the primary motions of the planetary masses round itself in circular orbits, by virtue of reciprocatory attractions. Now, it is a known and admitted fact, that the same force which can impart motion to a mass is *given back* on that motion's extinguishment, or, in other words, there is as much force required in the reduction of motion as there is in its inducement. Now, how are we to reconcile such a disposition of force and motion with the measures urged for the first and second laws, by which it was supposed to be generated. This equality of force and motion certainly can not be conceived to comport with our solar system's central force infinitely repeated, or perpetual in its action, for against what, we would ask, is this infinity of force directed? Were there no tangentile motion generated, it certainly would not be long in bringing the attracting bodies together; but seeing such is not, nor ever likely to be, the result, it must evidently be directed against tangentile or forward motion; or otherwise, by what means is it exhausted? Force against force in equability of power must be the order of planetary mechanism, either to extinguish or to perpetuate, the infinity of fall from the tangent in this case constituting the curves and constant motions of the masses, the central force constantly extinguishing all excess of the tangentile force that it generates. Were this not so, what could have been made of this infinite multiplication of force upon force, by this constant fall on the recognized principle of the motion of every moment being carried as a constant quantity to the velocity of the succeeding? If the accumulation of this force of fall, together with the influence of exterior attractions, could be prevented by the restraining force from the center, how long would it have taken this central power to dispose of any primary impulsion or initial momentum by its total extinguishment?

Setting aside, therefore, the primary impulsion principle of philosophers, to which there are not only insuperable objections, but a total want of information respecting the manner in which such motions could have been imparted, and seeing that the forces or affections of bodies as an effective continuation of the affinity of atoms is altogether sufficient for nature and for us, we shall not find ourselves called upon to estimate the densities of planets by their distances from the sun, as varying from the ponderosity of lead to the porosity of a puff-ball, as the inertial system of motion would signify and physicists usually calculate. The force which gave character to the constitution of our earth, acting everywhere in its own unrestricted individuality, could not possibly confine itself to any special or partial rule of action toward one mass more than another. But still that is no reason, as we shall hereafter see, why every planet shall be in density as every other planet, but it does certainly set aside the necessity to which nature would have been restricted had physical things been fashioned by such forces as philosophers have asserted. For causes and consequences being immediately associated with each other in the machinery of heaven, as in any other department of physics, the motions of the moment are there but the expression of the forces of the moment, and the conditions of the time are but the expression of the forces of the time.

There can be no difficulty in comprehending how the fall of a planet from its orbit, in every successive moment of time, becomes by transfer the tangentile force of every second next succeeding, for thus it is that one force is constantly made the equivalant of the other, a process by the infinity of whose angles or fall from a tangent all orbitual motions are constructed. It will likewise be perceived that in this operation of forces, central attraction will have much more to do than simply bending the body down to curvilinear motion, for it will at the same time have to balance or overcome its tangentile momentum thus acquired by the repetition of fell. Now as the ability of a body for this projectile momentum is usually understood as that inertial quality of matter by which *motion* is considered to be as much its condition as rest, and by which it (the ability) has been elevated to the undeserved dignity of being styled *the primary law of motion*, when in reality all its acts are only evidence of its secondary character, and this so-called inertial ability of a body to prolong an imparted motion, is by no means to be considered in favor of the idea of motion being as much the condition of matter as rest, or as once in motion always in motion until reduced by a resisting force, but is to be explained on the simple principle of the affinity which atoms have for atoms, by which affinity the constituent matter of any mass is not only attracted to its own common center, but is at the same time attractively affected by every surrounding body, as well as to those to which it may at the time be moving. These unsatisfied forces resident in the body itself are constantly seeking for satisfaction in the centers to which they are attracted, and must be as constantly defeated and ready for deflection on the application of any new power. We must know that the very constituent matter of any mass has tendencies to its own common center that never can be satisfied, while all matter can not occupy a point.

And, again, the whole must have attractive tendencies to all surrounding substances which they can never reach. Now all these resident and unsatisfied forces of a planet are, by the force of its fall toward its common center, deflected in the line last given, *from* the directions to which they have an affection. And they again, in their turn, deflect the downward tendency into a projectile or tangentile momentum, which it requires either time or external forces to extinguish, and in this case the central or restraining force becomes the extinguisher of this tangentilly deflected momentum, and this momentum can only be acquired by bodies as a consequence of the deflectibility of the unsatisfied forces resident in them.

It will be perceived here that the whole resident forces of a planetary body are at no time altogether deflectible, because, they being surrounded in every possible direction by attractions of some order of energy, any possible lines of motion the body could take would necessarily be a right line with some of them. Here, too, it will be perceived that motion subduing or extinguishing forces must be as much the resident of bodies as motions generating forces, in consequence of the deflected forces constantly applying themselves to a recovery from the deflecting impulsion. Thus it becomes evident that while attractive forces pervade the universe (as they must do while it remains one), the resident forces of bodies (usually called the inertia of matter) could never permit motion to be as much its condition as rest.

Now, by the simple affinity of atom for atom, and force against force, in an infinity of operative processes, we have seen how the whole region of the eternal universe was parceled out in primordial times, and the forms, magnitudes, and positions of aggregating masses secured. Following up the effect of the same infinitesimal energy, we shall have no difficulty in perceiving the further process by which it has worked out all the relations, associations, and peculiarities of solar systems. Secondary bodies, as we have seen, could only have concentrated their quantities in the most favorable situations among those vast regions intermediate of solar influences.

We have by one example only endeavored to illustrate the process by which secondary bodies were made to fall from their native places in space, and take their positions in our system. But it may seem (with universal attractions such as we may have signified them to be) difficult to account (by the effect of this force) for the orbits of all the planets being so nearly in one plane, and all moving and rotating in the same direction, or even how by this force they rotate at all, or how they should be so associated with satellites and annular substances encircling them, and these satellites likewise revolving in the same general directions. This has often been particularly urged and insisted on as a proof of the wisdom and management of the great Originating Power, and his particular designs, when he imparted to these bodies the initial momentums by which it is assumed they continue their motions, seeing the infinity of other directions they could as well have taken had he not ordered it otherwise. Now, although we may find the explanation of all this much more easy than by having had such an origin, still, as it is equally embraced in the Creator's plan, he can be no less entitled to the credit. Now, as all has yet been simple and easy of comprehension, no doubt it will still continue so; and in this further inquiry we have but to observe what would be the effect when, for the first time, a secondary body fell from its primary position, and made the sweep of the heavens. Forces would not only find for it a perpetual pilgrimage in the regions of space round our solar body, but these very wanderings would speedily disturb the relations of other bodies situated in some other of the remote regions of space, as it had once been; so that *all* having their places or positions approximate to that plane of the heavens in which it was traveling, would one after another be dragged from their respective nativities into the great vortex of solar power. And had it been (as we have assumed) that Neptune was the first planetary mass that made the great circuit round our solar sphere, or even had it been Herschel, or Saturn, or Jupiter, either distances from the center of power would have given their attractions so much influence over bodies approximating the plane of this great circle in the remote regions of space, as would have forced them from their moorings, and made them drag anchor after this new force. This being the initial of their motion, would unquestionably determine their direction in space to be like that of the disturbing body, and after this body, by its motion in space, had passed the regions of positional influence, they would still continue to descend by other compositions of force, which would be again modified by the periodical return of this wandering disturber, whose repeated effect would be felt more and more by these descending bodies, because of their constantly increasing proximity consequent on their descents, while the disturber was far away upon his periodical circuit. We not only perceive here the possibility by which planets made their entries into our system's superior government, and their passages round that governing center all in one direction, and in an approximate plane, but the almost impossibility that it could have been otherwise. Surely the forces by which secondary bodies were dragged from their native positions, and made to become members of some of our family circles, as well as those which sustain these relations being always associated in some order of composition, would unquestionably have been sufficient to decide that their directions in space should not be by antagonisms; for that in itself would be a physical impossibility, there being nothing of that character in nature; for a unity of force could have originated nothing in opposition to its own action. These associate forces would not only determine the motions of bodies to be in one direction, but would likewise rule as to their relative places, in which they were ultimately to perform and perpetuate orbitual motions. For, by resolving the initial paths of descending bodies to be at some certain angle to a solar perpendicular, their ultimate places would be determined; for as that was obtuse or acute, so would their distance be from this grand central force round which they were to circulate. The present position and motions of planets, therefore, is but the visible and necessary effect of the composition of associate forces, which have ruled conditions as they are and must be in an eternal perpetuity, for nature never takes any thing back. We may readily perceive that in all this outlying order of secondary bodies the largest would be most likely the first affected by a disturbing power, because of their greater attractive susceptibilities; and as they were one by one taken up, their order of motion and repetitions of effect would still be the further means of forcing others to fall from their native positions and follow in the same direction, each affecting each in their respective revolutions round the great circle; and more decidedly in the important particular of their dragging each other in one direction. It will be seen that such must have been the necessary consequence of that order of forces which first caused motion at all, and ruled that the motion of the body first introduced into our system should be from west to east; for, that being the direction of one, and each causing the initial motion of each, all would, from the very necessity of the case, have to travel in the same direction with all, being that they could not go in opposition to the forces thus affecting them.

This planetary problem, as thus solved, is certainly conclusive of how they came to pursue the same direction in space, and surely nothing can be more simple or more *certain*. Here we find no need of those special and miraculous exhibitions of power which are usually attributed directly to Omnipotence, as if physical nature were at times unable to consummate her own purposes, and was compelled to evoke direct help from the Being who gave it birth. By these very forces which have resolved the direction of planetary motion, we have likewise the solution of the problem of their approximating so nearly to one plane, for we have but to contemplate a series of bodies (situated in a certain zone of our solar force's superior convexity) as subject to the disturbances we have already considered consequent, from the intrusion of the effect of a mass among the forces, by whose equality they were suspended, and we shall be satisfied that as this intruding body made its way in but one plane of the heavens, it could not have affected remote objects far on either side of such plane; and hence it comes that the inclination of planetic orbits are confined to a zone of the heavens of such comparatively narrow limits. Other secondary bodies situated as these were, around our solar sphere's vast convexity, and in the two hemispheres of the heavens, not being so sensibly subject to the attractive influence of this ecliptic plane, may, probably, and we may almost say certainly, have fallen into other solar spheres exterior to ours, and as making up their associated memberships of planetary bodies. But as confining ourselves to those of our own system will be sufficiently illustrative of the general principles upon which all are regulated, we will remark, in connection with the direction and plane of our planetary motions, that their elongated orbits are sufficient evidence of the approximate points of space from which they must have descended. Let a line be drawn through the center of gravity for our system, and continued through their duplicate foci in its extension into space, the aphelion projection of this major axis of their orbits would indicate approximately from whence they descended; for if this position of the heavens has an attraction from external regions which could have suspended them there during the lengthy periods of their incipent formation, that attraction would surely continue to operate upon them at every periodical return to that part of the heavens where the maximum of this influence prevailed, and this would necessarily cause the elongation of their orbit into more or less of an ellipse, that is, more or less elongated proportional with this force, the sun forming their perihelion or *internal* focal force, and the attractions from their native positions in space forming their aphelion foci of *external* force. While this is an explanation why the major axes of their orbits point to different parts of the heavens, and that their inclination to the ecliptic are so various, these positions of their orbits present the best possible proof that such external forces must prevail; for were they not attracted by such outward influences, the gravitating effect of the planetary masses upon each other would have constantly tended to a contraction of the angles their orbits formed to each other, until they were ultimately forced to follow after each other in a perfect plane, for their own forces would inevitably be equal to this were all external forces equal with each other. Now, as we see this effect does not prevail, we must be convinced that there are such outward forces, and in these particular directions, between whom and the mutual affinity among the planets themselves there must be an equable compromise, of which the present angles of the orbits of the planets to each other's plane is the sensible expression. As we have already seen, no planet could be in itself the native repository of a force effective only for the preservation of that body's condition (whether of rest or motion) against other adverse force, because no single force of impulsion could continue good or maintain itself against a force of infinite repetition. A permanency to orbitual motion would therefore be an impossibility *without external forces,* and even were these external forces spherically uniform, there would be nothing to cause the elliptical orbits that now prevail with the planets; for this spherical uniformity of outward action balanced against inward attraction would, most assuredly, be insufficient to make a body elongate its curve; for there being but one foci of force, there could be but one uniformly circular motion; and whether that could even be a permanent one is somewhat problematical, for that single foci of force, which could bend the motion of a body *round* itself, might, in process of time, bend the body *into* itself by convoluted curvatures. The very circumstance of a duplicate foci to the orbit of the planet is as much the evidence of an internal force for one of them as that the sun's attraction is an internal force for one of the foci of their satellites, while they themselves furnish the force for the internal foci of these same satellites.

Now that we have thus far endeavored to exhibit the processes by which planets were originated and their positions and motions secured, it must not, under any circumstances, be understood that at this introduction of these bodies into our solar system, that the aggregation of the matter in all solar space had been perfected, or that the matter then constituting these masses had acquired any thing like the same bulk or solidity of form which they now possess. We shall have much to say of matter and its phenomena before the completion of these aggregating processes. By the simple affinity of atom for atom we have succeeded in demonstrating the principles on which planets are perpetuated in their motions round a center—why they all move in the same direction—why their orbits are so little inclined to each other—and why there should be any inclination at all—and what the relation between such inclination and their ellipticity. It may now be both important and proper to explain how this simple affection of matter can make the planetary masses rotate round their own respective centers in given periods of time, as they are now found to do; and that these rotations should likewise all be in the same direction with their forward motion or orbitual revolution round the sun. With this we apprehend but little difficulty; for if the affinity of atom for atom, according to what we conceive to be the rule of nature, will not explain every thing, it will not be expected by us any longer to explain any thing. The only difficulty we have here intruding itself upon our notice is the incomprehensibility of this problem of rotary motion having remained so long without its own proper solution. We find that, so far from seeking this solution, physicists have satisfied themselves with the simple recognition of planetary rotation as a naked and unassociated fact, which is held by them to be the best proof of what matter could make of its own inertia through an impetus imparted at the beginning of time; and as a proof of what is conceived to be the first law of motion, this is considered to be a motion altogether simple and self-perpetuating, in virtue of the native inertial quality of the masses in which it is exhibited as consequent on initial impulsion, which is conceived to be the most conclusive evidence of motion being as much the condition of matter as rest; for, say they, here are bodies that have gone on rotating through all recorded time without retardation or acceleration, to the extent of one known second. Now, so far from rotary motion being a proof of any such proposition, we hold that its testimony tends positively to an opposite direction, for the properties of the problem are to be found without difficulty in the forces which even physicists themselves define to be *attractive*. The gravitating force, they say, has a rate of diminution outward from an attracting body, in the ratio of the square of the distance. Now this rule requires but to be followed up; and the great problem of rotary motion reveals itself as a self-solvent principle, and decides rotary motion to be inevitable, for no such distribution of force could be equally effective on the two sides of a mass that measured unequal distances from the gravitating foci. Let us contemplate the attractive energy of our system's common center as it operates outward as far as the orbit of Jupiter, in the inverse rate of the square of the distance, and endeavor to ascertain what its effect on that body would be under such a rule of diminution. A moment's reflection will satisfy us that the lower limb of Jupiter will be far more affected by this attraction than the upper one, in consequence of its being (by its own diameter) nearer the foci from which the force radiates that rules his motion. The distance across the disc of that body must, at the usual rate, cause some considerable diminution of gravity, and would proportionally affect his mass and motion; to this rapid decrease of the gravitating force that body would be unequally exposed. The rate of diminution continuing outward through the body's whole mass, we must perceive that the upper limb would be more at liberty to move forward in space than the lower limb, which would be subject to so much more restraint. We have seen (what is by all admitted) that the central energy acting at this decreasing rate, makes the planets fall from a tangent to their orbits so much in every second of time, and that the fall of one second is transferred into the forward motion of the next: but this forward motion must be far from equally free in all parts of the planet. Were the attractive force by which the body is made to fall of equal energy throughout the whole mass, all parts being equally affected thereby, the body would make but one rotation on its axis while making a revolution in its orbit. But by this inequality or diminution of force the lower limb is continually restricted and held back in its tangentile speed by this preponderance of gravitating attraction over that of the upper limb, which being so much more free to exercise tangentile motion, carries itself forward in advance of the restricted limb, and consequently communicates to the mass a rolling motion.

Were we to suppose the gravitating effect on all sides of a planet to be equal, and that thereby it could not rotate at all, but that a fluid medium was in the occupancy of its orbit, with a density decreasing across that path and its diameter, with the same ratio of diminution as the gravitating force, no one would question but in such a case the body would acquire a uniform rolling motion (as it was forced forward in such a medium), in consequence of the unequal obstruction presented to the two sides of the body. Neither will it be disputed, that were the diminution of density in such obstructing medium inverted, it would balance the corresponding inequality of the gravitating effect as it now operates. The body, in this case, would have no rotating motion at all. If, therefore, we can so readily comprehend what would be the unquestionable effect of an unequally interposed medium of a fluid character, we can perceive no difficulty in apprehending what would be the effect of an unequally interposed attractive force. Where there is, as in this case, an infinitely repeated *effect*, there must necessarily be an infinite repetition of *cause*, and we know of no force that could be the means of this infinity of effect, but the everlasting and immutable exercise of gravity. And as no body can by any possibility have its gravitating energy concentrated in a point, it necessarily follows that bodies must gravitatingly affect each other's masses very unequally, for no several parts of any body that involves *bulk* (which all bodies do) can be subject to the same degree of its power, because of unequal distances from their own common centers, and from the bodies by which they are attracted. Where such must be the case with every mass, however minute, surely its effect will not be inconsiderable when operating upon bodies of such diameter as our planets, particularly the largest of them, as in that of Jupiter, whose diameter is so extensive, and its effect so conspicuous, as that his rotating motion is not much inferior to that of his revolution round the sun. Of this we are constantly made sensible by the tides of the ocean, which are its unerring indications.

We certainly could not have a much better proof of the effect of unequal obstruction upon a spherical body in motion, than we have in this exhibition of two oceanic waves of elevation on opposite sides of our earth at the same time. The restraint of the centrifugal effect by the force of gravity upon the earth's lower limb elevating the aqueous fluid by a subduction of its innate affinity for the body to which it belongs, is certainly evidence of a force somewhat obstructive of free motion; while, on the opposite side, where our earth is less restricted by gravitating energy, there is a corresponding tide caused by the more free action of centrifugal energy, a force which causes the like subduction of the affinity of matter for its common center of gravity, from which it is more readily swung forward by its own rotating momentum, by being of fluid character. This greater freedom of the outer side of our earth to fling itself forward in space (of which a fluid must be the best, if not the only sensible indicator, it having freedom of motion among its own particles), is certainly proved beyond controversy by the exhibition of these tidal waves in opposite sides of our earth, which will be found to explain in a much more conclusive manner than any other existing hypothesis all the phenomenal facts for which it has been otherwise difficult to account. These tides approximating as near as may be expected from the inert character of the aqueous mass, a line passing from the common center of gravity throughout the center of our earth, the rotating motion of the earth and the tidal waves of the ocean are consequent from the same cause, and confirmatory of their origin as being but the sensible expression of this inequality of the gravitating effect upon the opposite sides of our earth, which is still further indicated and established by the greater elevation of these oceanic waves, when the force of the moon is acting in conjunction with that of the sun; for, in such case, the two forces acting together is certainly better calculated to increase the gravitating and restrictive effect of the earth's most conjunctive or approximate matter on her lower limb for the common attractive center, the consequence of which is, that this combination of force becomes most sensibly effective upon oceanic fluidity, it being most susceptible of sensibly responding to the force, as is evinced by its wave of elevation in the direction of this force. The apex of this wave being constantly somewhat behind the line of conjunctive force, proves that such force can not effect the instantaneous motion of matter into perfect coincidence with itself, and that the aggregate of this wave and force must be to retard, to some certain extent, the forward motion of the earth's lower limb, while the exterior limb, because of gravity's rate of diminution by distance, will have greater freedom of forward or rectilineal motion, in virtue of the constantly acquired momentum consequent from her infinity of fall from a tangent being less obstructed at this time, by which it will be tangentially swung forward in constant advance of her most highly attracted side, and by which will be equally imparted that rotatory motion about her own axis, which physicists erroneously assume to have been by a primary impulsion. This very repetition of fall from a tangent and tidal waves of the ocean is certainly conclusive that the force which can effect both must be of such a powerful character as would soon have extinguished any initial impetus that could have been primarily communicated to our earth, as a cause of her projectile or rotatory velocity, on the principle of motion being as much the condition of matter as rest, which is so absurdly assumed; or had the earth's rotatory motion been caused by any special and primary impulsion, such as physicists fancy, it is certainly very evident that the constantly transferable force of these tidal waves and their friction upon the more solid portion of the earth would have soon brought such rotatory motion to rest. By the attractive affinity of matter, we find that the motion of nature's machinery was not made to depend upon any such inadequate primary impulsions, but that the force of every moment is in equal repetition with the motions of every moment. We are here anticipating the consideration of the tidal waves of the ocean before we have even contemplated the formation of the aqueous substance which forms the ocean, but this is because we find the same effective forces which gives tangentile and rotatory motion to our earth, to be precisely identical with that which formed and gave motion to her waters, and that one order of phenomena proves the principles on which the other is conducted, so that they reciprocally establish the forces that are effective of each other, and at the same time are decisively conclusive against the doctrine of any perpetuation of motion by initial impulsion as physicists now have it.

We find, in following this connection, that although the combined effect of the forces of the sun and moon, when acting in conjunction upon the forward and rotatory motion of the earth and tides of the ocean, are not constant, yet they are in their general relations compensatory; for when these forces are in opposition, they must, to some certain extent, be reversed in their effect, in so far as when they are acting simultaneously upon the earth's inferior limb, and thus furnishing the maximum of retardation and tidal wave to this inferior surface, the superior surface is thus left more free to swing itself forward in its tangential motion, and thus elevate the superior wave by virtue of this accelerated momentum of the fluid and more free substance, or, rather, its less attractive force in falling from a tangent, than the waters on the earth's inferior side; besides, this greater freedom for the earth's solid exterior would compensate for the greater restriction of her inferior or conjunctive side. In this manner, and on these principles, the observed tides of the ocean may be contemplated in that harmonious accordance which should always characterize cause and effect, and with which the usually assumed laws of motion have not such perfect parallelism.

When these forces of the sun and moon are acting in conjunction, they are necessarily both restrictive of tangential motion, and would induce a greater fall from this tangent, only for the more free momentum of the earth's exterior side, in which its effect is compensatory; and the mutual attraction of the moon and earth must, upon the earth's superior surface, when in opposition, have the effect to retard rotatory motion, because the moon, though moving in the same direction of the earth's rotation, is not, by about one twenty-sixth, as fast; therefore it must have the effect, in some certain degree, to retard the more free swing forward there would be to the earth's superior surface in causing rotatory motion than were no such lunar attraction thus interposed. Conjunction, by opposing a greater restraint upon the earth's lower limb, necessarily leaves rotatory motion more free, by the exterior surface being less restricted in the exercise of its acquired momentum. Opposition, by acting on both sides, must, to some considerable extent, leave rotatory motion less at liberty in its revolutions. But this variability of attractive positions, although having a sensible effect upon the waters of our earth in the construction of tidal waves, is so compensatory as not sensibly to affect the solid mass in the equability of its rotation.

We thus find the rotation of the planets around their own axis to be a necessary consequence of their revolutions around the sun. We likewise find in the spherical formation of our planets that they must have been all circulating in our solar system, and performing diurnal revolutions round their own centers, while their component matter was yet in a fluid or semi-fluid condition; for had it been otherwise, their equinoctial diameters would not even now have been equal to the effect of centrifugal action caused by their diurnal revolution, and the consequence would have been the elevation of the ocean high above all the more solid matter of the earth, particularly at the equator, while it would have been in corresponding depression at the poles.

This evidence of their insolidity being unquestionable, is again demonstrative of another fact, which is, that while the planets were in such fluid condition, their axis of revolution and rotation must necessarily have both been in one plane, as there could have been no existing cause for their being inclined to each other in the smallest possible degree. Orbitual motion, with unequal resistance across the moving body, being the prime generator of rotary motion, in a fluid mass, it could not have inclined the centrifugal plane, or the plane of the equinox, in any degree from the plane of its own path.

Now, agreeable to the formation of things by the force of gravity, we perceive that our several planets, by being in a plastic state, could not have performed their respective orbitual and axual motions, except in the same plane. Such would certainly seem to signify that the system which would so surely beget such a condition of things can not but be erroneous, as none of our planets are now found restricted to any such rule as causes in them that perfect coincidence between their respective planes of revolution and rotation, as the attractive force alone would determine. We will not anticipate, but simply remark here that while this ruling force would make sure the perfect coincidence of their planes, it could only be done when the masses were in a fluid state, fluid conditions being such as would under no circumstances *restrict* the full operation of gravitating force in causing this coincidence of motion.

We have already observed, and may now calculate with certainty, that our planetary masses were the first outwardly aggregated bodies that gravitating force ruled to their positions in our solar system, their magnitudes making them more subject to gravitating affinity, the relative rates of motion among bodies being in the ratio of the force exercised by each constituent atom. After the planets, agreeable to this rule, would follow masses of lesser magnitude, or those by which the planets are now accompanied in their annual circuit round the sun. But these associations could not have been formed separate from our system, because the balance which could originally have sustained the planets or primary masses in a stationary position, would have been incompatible with such an outside force as would have caused the revolution of satellites. But these unfavorable conditions would no longer exist *after* these planetary bodies took up their position in our planetary sphere, because each of the planets themselves would then constitute a force by which one foci of an elliptical path could be formed, and our common center of solar gravity would constitute the other. Having thus the essential elements for the formation and perpetuation of elliptical motion, it will not be difficult to perceive by what means it was that the secondary bodies were made to take up their positions and circulate round their primaries, and with them round the common center of gravity. The planets being the principal forces by which these secondary bodies were made to fall from their native positions, would necessarily incline them more or less to that direction in which they themselves were traveling. These forces, and that of our common center of gravity, increasing in a given ratio as the bodies descended from their positions, would have a correspondingly increasing effect upon their motions and paths, and those planets being in greater proximity in that part of their passage where their own and the central force acted in conjunction (which would be at each return of the planet in making its circuit round the common center), would very much influence their directions and motions, which would be increased at every periodical return of the planet until the attractions were of sufficient force to urge this descending body onward with the planetary mass while making its circuit round the sun; in which case, by its forward projection in following the planet and its fall to the attractive center, it would, by this new combination of force, form for itself an orbit of ellipticity, having the planet as one of its foci, and the force of the sun continually forming the other.

Thus with all the requisites for its perpetual appropriation, this secondary body would be made to revolve with and around its primary in endless perpetuation. Had the force of one planet been insufficient to have appropriated the body as a permanent appendage during one transit, it is quite possible that before the planet could have made another revolution of the heavens this secondary might have fallen below his path. In such a case it would be forced to fall farther for a permanent position in our system, or follow the fortunes of the planet on his return. The first would, in almost all cases, be the most likely to take place, for by the constant fall of the body, the central attraction would so continue to increase as to render it impossible for the falling body, after being within the planet's orbit, to follow and ascend round the planet as an inversion of that order which existing energies would force to prevail. But as there is a possibility, there may likewise be a *probability*, that such a phenomenon may have taken place under circumstances the most favorable; and if so, there can be no more obstacle to the perpetuation of such a motion when once formed, than to that which usually obtains. It is strongly suspected that some of the satellites of Uranus follow this inverted order of motion, which in reality is not so much surprising when we take into consideration how vastly remote that planet is from the center of attraction, and how feeble that attraction would act on the falling body. We may expect to find both his and Neptune's satellites circulating with less respect to the planes of their orbits or their directions than the more interior systems of secondary character; these outside orders not having penetrated sufficiently far to feel the full effect of such forces as have ruled the more systematic order of the inside systems, and bent to partial coincidence with their own the paths of their several members.

The angles which the paths of satellites may form to the orbits of outside planets may possibly be very great, but there is no probability, or even possibility, of their ever being found to circulate at right angles. Because by whatever direction they may have descended toward these planets, their *forward motion* must have imparted to them a part of their own direction. Inverted orbits or motions, at almost every inclination save that of right angles, are likewise possible, because of the feeble effect of central attraction upon falling bodies. The slow motion of the remote planets, and the length of time they take to make their revolution, may make them pass a secondary body on its descent at too great a distance to force it to follow them on that passage. The progressive descent of such secondary may have brought it below the path of the planet before his next periodical return, although not so far but it must yield to its attractive force, follow, and become a subject of this new system. If so, and being below the planet, and following somewhat in the direction of his path, it is certainly very evident it could not revolve round him in the usual direction of from west to east; for to do this, it would have to retrace its descending course, and again rise above the planet's path in the rear of that body while making its revolution round him, which would be a contradiction of all the rules of motion, and therefore not to be thought of. But having passed below the planet's path before the consummation of this social and eternal compact which binds them together, and having no reason to retrace its descending way, its revolution round him could only be in an inverted order to those bodies that never pass below the planet's path, but in advance of that body while making their revolutions round him. Thus it will readily be perceived how it was that both planets and satellites were dragged in succession into our system's association by a sweeping of that zone of the heavens in which they had their nativities first, by a displacement of one of their number, and then by the disturbing effects of each other while sweeping round this great circle, and how they were disposed of as they severally fell from the positions in which they were partially aggregated. The attractive grapnels of one disturbing the balance of the other, and the combination of forces preventing perpendicular descent, it is likewise very perceptible how secondary bodies were intercepted in their fall toward our system's center by the planets in their periodical passages radiating so many rays of entanglement as to gather them all up, and variously appropriating them among the most superior masses of larger magnitudes. Indeed, this gravitating energy of planetary masses has guarded the the heavens so effectually, that but one of these secondary bodies has been permitted to pass below the path of Jupiter, except in their revolutions round him. And it is really surprising how our moon could have escaped becoming an appendage to that or some other of the extensive masses so constantly sweeping the heavens in their circuits round the sun. He and they must have been on the opposite side of the heavens when our moon or any of the inferior planets that circulate within his orbit, were on their passage inward, for their powers of appropriation are so great (of which we have ample evidence in the magnitude of his and their masses and the number of their subordinates), that we can not well see how inferior bodies could have passed through that space in which their power was predominant, and have escaped their absorbing influence, even while they were absent on their periodical circuit of the heavens.

Now it may be supposed, and perhaps urged, that the motions of planets, while describing their orbits round the sun, could not impart to, or permanently change, the direction of any body descending into our system from outer space, being, as it may seem, that the attractive force of the two bodies toward the intersecting line of their passage or point of maximum intensity would be equal and compensatory to that exercised after such passage. One force being thus assumed as the equivalent of the other, may be supposed would neutralize any permanent effect, so that their motions would be equalized as before. Now we conceive that it will require but a slight consideration of this subject to remove the misconception to which such an erroneous idea may possibly give rise. For although we find compensatory conduct in planetary motion in general no uncommon thing, it will by no means apply to bodies circumstanced like these, and could hold good in the planet alone were the other body a fixture. But such not being the case, it necessarily follows that the planet while advancing in its path, and coming within the gravitating affinities of any body descending toward the center of our system, would affect and be affected according to their respective masses.

These forces, while tending to conjunction, would be in opposite directions, the path of the descending body would therefore be proportionally bent toward the approaching planet, and the planet being proportionally accelerated in his forward motion toward the descending body, would shorten the time otherwise necessary to reach that point in its orbit at right angles to this body's descending path (which would be the maximum force and effect consequent from progressive approximation), this maximum force being partially made up by diminution of distance consequent from the body's fall. Now these mutual forces, besides being thus increased in intensity, would continue their effect much longer as one body was receding from the other, with their motions in one direction (however different their speed), than they could have done during their approximation with their motions reversed so as to be in meeting directions. Thence it was that remote masses of matter merging toward one great central attraction would be made to follow in the direction of the first disturbing mass, because of their mutual effect on each other communicating to the whole one general tendency. These mutual affinities being so vastly remote from the effect of the all-absorbing central force, would have ample time to operate upon each other in the manner we have indicated; all which is deducible from gravitating energy. Although the possibility exists, as we have already seen, that in remote space there may be exceptions to this general rule as regards secondary bodies, and the more remote, the more such exception is within the range of possibility, because the lateral position of a descending body would make its angle more obtuse to the path of an exterior planet, because of its being so remote from the center, and whose comparatively slow motion would affect it longer and farther than those circulating in inferior positions; and they by being so remote would have a greater range of action each side the plane of their orbits, which would be calculated to cause the orbits of their satellites to assume greater inclinations. Such inclinations of orbits, therefore, are to be inferred only from the relative positions the secondary or satellital masses must have primarily occupied with respect to the orbitual planes of the planets round which they revolve. The more remote their native position from such planes, the more obtuse the angle of their orbits would be to the path of the planet. Any secondary bodies thus circulating at high angles to the path of their primaries must necessarily be considerably remote from them, or the superiority of force exercised by their equatorial enlargements would finally bring about greater coincidence in their planes of revolution. In all the moving machinery of our great planetary system, there is not a motion or inclination that is not solely attributable to the constant force of gravity; therefore there is no continuation of motion by initial impulsion indicated here. Indeed, there is nothing that is not necessarily consequent from the operation of that great and all-important energy, as existing conditions will fully testify. We have already deduced from that power the relative position in space of our great system's permanent center; we have seen the necessity of its final aggregation in mass of all the matter immediately within its very comprehensive sphere of action. This being the only permanently aggregating point of the whole, no portion within its vast range of power could have been perpetuated apart from this mass, as there could (at this time) have been no combination of forces present which could have caused in any of this vast field of aggregating matter the required motions of conservation; and this accounts admirably for the enormous magnitudes, not only of this central mass, but of solar bodies in general, when compared with those by which they are surrounded. And these, on their part, in consequence of their separate action, prove their origin to have been on the confines of this great central energy, or, rather, situated between such primary aggregating influences, and these equally balanced by all. The relative magnitudes of the planets, and the number of their attendant satellites, are exactly what might be expected under such circumstances; and we may even go so far as to say that they could not have been otherwise, or God's application of energy to matter must have been different.

We find the very remote planets again getting smaller, and less numerously attended than those next in inferior position. This is, no doubt, because of their being so remote, and consequently slow of motion; and though they may at first have disturbed stationary masses exterior to themselves, yet the vast interval of time that would necessarily elapse between their leaving any such disturbing point and their return to it again, would afford opportunity for the introduction of much matter within their vast orbits and their special powers of absorption, which would be much more subject to interception by the next inferior planet, in consequence of its having greater concentration of energy and rapidity of motion, thus rendering more restrictive the positions at the different points of its orbit. This possibility, therefore, of the inward passage of masses of matter being more and more intercepted at every planet's path, consequent from their contraction of curve, and increase of velocity, and augmentation of bulk, would, at Jupiter's place, amount to almost a total prohibition, the force of that mass being so effective, that an escape from interception would be less likely to occur than in any other circle of convergence. The present conditions and relative positions of all the masses that belong to our planetary associations proper, indicate, with a very great degree of certainty (as we have already seen), that they were all derived from a belt in the heavens, occupying but a limited range each side of the plane of the ecliptic. But it would be very surprising indeed if there were no exceptions to this general order of the nativity of internal masses, for there must have been around this vast sphere many other situations than in this planetary zone of origination, where masses of matter could have been aggregated, and from which they may have descended into solar government. But at the same time we must consider that there were many surrounding suns and planetary systems to be made up and supplied with material substances and circulating bodies as well as ours. This may here be regarded as speculation, with which we profess to have nothing to do, confining ourselves to nothing but truths that are self-evident from the circumstances, so that in self-defense we will simply say here, that we will conclusively prove, in its proper place, that all the fixed stars are suns, and that they are one and all surrounded with systems of secondary bodies somewhat such as ours, and no doubt those in greatest proximity to our solar sphere were so furnished from the dividing space between us and them, and from the two hemispheres divided by that zone which furnished our secondary bodies.

It would be inconsistent to suppose that our system appropriated more than a very small part of these remote outlying masses, for her grapnels seem to have been thrown out only in one direction or one plane of the heavens, leaving for kindred and more convenient suns the supplies of all the other quarters, from all which we may safely infer that they circulate around their primaries in planes very much inclined to those described by our planets. In this general distribution of the inferior masses of matter, and somewhat contrary to the common rule, there seems to be a considerable numerous family of small bodies that our neighboring suns let slip into our system, for we find them with many characteristics uncommon and seemingly of an independent origin circulating inside the orbit of Jupiter. All the planets and satellites which make up the several regular systems, and the matter of which they are mostly composed, have descended from that zone of the heavens comparatively but little divergent from the plane of their orbits. It certainly would have been at least very surprising had no material bodies entered it from any other quarter, or at angles greatly divergent from the paths of the planets proper; they are all of an order large and well-regulated in their relations, from the very circumstance of most of their constituent matter having been accumulated from an approximate plane in the great circumferent sweep of solar action while making their particular circuits in this zone of the heavens, would permit no body or substance to pass without being appropriated by one or other of them, either in coalescence or as an encircling body, and hence it is that they have acquired much of their present magnitudes and encircling satellites; but this was not so with that family of more independent wanderers known as the asteroids: they, in their approach to the center of gravity common to all, having entered planetary space at high angles to the orbits of these bodies, as most of the existing cometic masses generally do, would thus escape being absorbed or appropriated by either of these bodies, and there being no large and powerfully effective bodies making their revolutions in an approximate plane, these meteoric masses would take up such orbitual positions as the combination of external forces affecting them should determine. These bodies are to be regarded as having consisted of matter whose attractive effectivity in the aggregate was somewhat intermediate between that which compose the planets proper and the existing comets, their present visible magnitudes being but the more effective nucleus portions; all of their exterior enveloping matter that could assume a nebulous aspect when involved in the far-extending envelope of the sun or planets having been thereby absorbed, the residue still left being sufficient to cause solidity to that portion of their matter which is now visible, and this solidity in some of its forms may be safely inferred because of their reflections of light. Had it not been so that substances entered our system at high angles from the orbits of the planets since they circulated round the sun, we would find their superior and subsequent accumulations all heaped upon the equator, which certainly has not been the case, seeing there is so much of it piled up, more particularly in the northern hemisphere, and which becomes readily evident when compared with the sea level. Now although these bodies are found so abundant between the orbits of Mars and Jupiter, this is by no means to be regarded as any evidence that they may be equally plentiful beyond that planet, or between that and Saturn, for, in the first place, these bodies in descending from space, in obedience to our system's center of gravity, would be much more apt to fall within the orbit of Jupiter, between whose force and that of the sun they would be ruled into their present positions in the manner that may be possible for mathematicians to calculate; and, in the second place, had any of these bodies descended between the orbits of Jupiter and Saturn, and there been prevented from descending farther, one or other of these two bodies would have appropriated them to itself, each being so powerful and the descending body not having so much of the force of the sun to act in its conservation.

Now this manner of accounting for the origin, introduction, and seemingly independent relation of these numerous bodies, not only by being in perfect accordance with the true processes and principles of nature, is certainly in itself much more consistent than the usual supposition of a large planet having been exploded by its own internal forces and its fragmentary parts thus scattered in space, giving to them their eccentric motions, an idea entertained, we should say, at the expense of both good sense and sound philosophy.

These bodies must have eluded the vigilance of Jupiter by making their descent at a very high angle to the plane of his path, otherwise they could not have all escaped the appropriating power of that body's attraction; and as it was, there can be no doubt but, situated as he is with reference to them, his force had much to do in determining their relative positions and directions and even their present motions, for he certainly exercises uncommon power over them—enough at least to have modified very much the sun's force upon them. Had Jupiter's influence upon these bodies been, to any considerable degree, greater than it was, that is to say, a fraction more than the sun exercises, we should have found them now circulating round him as his satellites. But in that case their order of motion would not only have been very much inclined to the plane of his equator, but would likewise have been inverted or contrary to that which is the usual course of both the planets and their satellites. This inclination and inversion would necessarily follow as a consequence of their coming in under, and at a high angle to, his orbit. But as it is, however, their distances from him having been sufficient to allow them to form for themselves independent orbits round the sun, as a consequence of his superior energy, and their distances being so great, and the respective masses so small, we must necessarily infer much greater eccentricities of orbit for them than for the larger planets, because the sun's attraction could not have the same effect on them, situated as they are within the influence of Jupiter's attractive power, which must in part determine their orbitual relations. Their relative sizes and remote positions are well calculated to give greater comparative effect to the external forces which give elongation to their orbits, or which form what we may call their external foci.

We have already demonstrated that in all this vast sphere in which our sun is situated, and over which his attractive energy is predominant, there can only be one point in which all external attractions are equal. It is sufficient to say, therefore, that in every other point they must be unequal, affording a vast field for diversity of force, in all which there must be an infinity of directions in which greater or lesser energy is exerted. The existence and direction of some of these forces are certainly well indicated by the direction of the transverse axis, or aphelion foci of the orbits of our planets, and more particularly those small bodies we are now considering, which are in planes so much inclined to the planes of the other planets' paths, but which, nevertheless, must have great effect upon them ; in that zone of the heavens in which our planets' paths are usually projected, external forces must be somewhat considerable, or the attractive effect of the planets upon each other would be to force all of them to occupy one plane ; although there are no great elongations of their orbits, yet when we consider their mass, and the extent of the sun's energy, it is almost surprising to see them so much affected as they are by these external forces ; for the very circumstance of so many bodies sweeping the heavens in approximate planes, we should suppose well calculated to equalize in some degree all permanent forces external to these planetary orbits ; because of the mutual attractions of masses being in themselves self-adjusting, the position of outward bodies must, to some certain extent, depend on inward influences, otherwise all could not be connected with all.

The greater eccentricity of these small planets is but another proof that external forces are essential to the formation of elliptical orbits, or, we may say, of planetary orbits of any order, for we have already seen they can not be other than elliptical and have permanency. In these small bodies we perceive a much greater effect than such forces could have upon such masses as the larger planets. The inferior planets, *i.e.*, those next the sun, being comparatively small, and having but a slightly elongated orbit, is accounted for by the greater intensity of the sun's action and the lessened effect of external force. Why the larger planets being so much farther from the sun are not more elongated in their ellipse, is because no attractive point in the external heavens can have much effect upon such extensive masses.

The small planets we are now contemplating, and which are somewhat out of the usual order (having their orbits projected on a different plane of the heavens from the planets proper), being so far removed from the sun's influence are more subject to the effect of external forces, which form their aphelion foci, and cause considerable eccentricity, as we see exemplified in their orbits. This family of asteroids are not the only bodies belonging to our system considered somewhat out of the usual order of formation and motion, for we have annular masses encircling some of our planets, at least that of Saturn. And we are often visited by erratic bodies, whose ellipticity of motion and consistencies of mass may be somewhat indefinite, as well as seemingly altogether irreferable to the action of gravity alone. But as it would be premature in the present stage of our inquiries into physical development to discuss their relation to that force (not yet being possessed of the necessary data), we will defer their consideration for the present, with the simple premise, that they will prove themselves to be as much the subjects of that force exclusively as any mathematical demonstration can make them. In contemplating the manner in which planetary masses were brought to circulate in obedience to our system's attraction, and specifying the positions in which they were aggregated, we must not be understood as signifying that they were altogether aggregated, or had acquired their present magnitudes in their native positions, for there is sufficient proof of their having obtained vast accessions of matter after entering our system and encircling its center with their orbits. Had all matter been aggregated, and the masses obtained their magnitudes before these bodies had left their native localities, they would never have left them at all; for, in that case, the relations of all with all would have been adjusted as permanently as it now is, and the only bodies that can now be in their native position, are those which are the centers of the several solar systems, and most of them are swung round their centers by the force of the planetary masses encircling them. Certainly there is nothing more evident than that there could have been no permanency in the relative position of bodies while the massive aggregation of matter was incomplete. For just so sure as no body could have departed from its position after gravity had consummated a final aggregation and consequent adjustment, just so sure is it that no body could have materially departed from its position during the early process of that adjustment without changing more or less the positions of all, and becoming itself a part of the central mass. From these facts, therefore, it must be evident that masses circulating, not only in our system, but in every other, must have been induced from their primary positions, while the aggregating process was still going on. And, indeed, many of them may never have had any very settled locality at all, and all must, more or less, have added to their respective magnitudes during migration. But what these magnitudes were when they severally assumed their places in the respective systems in which they now circulate would be very difficult to define. But of one thing we are well assured, namely, that their constituent matter (however great its mass may have been), as we have already noticed, must have been either fluid or semi-fluid, or their forms would not now be fashioned so much in accordance with the forces flowing from centrifugal action. Here it may not be improper again to notice the very important fact, that while matter was thus susceptible of assuming a spheroidal conformation in accordance with their rotary action, the axis of such rotation must have been at precisely right angles to the plane of their orbit, that is, if gravity was the force by which these motions were formed, and there are no natural deductions which can make it otherwise, while its confirmation is more and more established by every phenomenon in connection therewith; and nothing is more conclusive of the fact than the very circumstance that may seem at first sight conclusive to the contrary, and that is, none of their revolutions and rotations are *now* in the same plane. This paradoxical proposition, that the same force which could not do otherwise than form this coincidence in the planes of revolution and rotation should thereafter be as rigorously restricted to determine against it, is one which will fully explain itself as we progress, besides at the same time bringing to light the cause of some very important phenomena that have hitherto been very obscure.

Now that we have contemplated the action of gravity in the formation of masses, and their associations in our system, while yet their equatorial and orbitual planes were one, it may be as well to observe, that as matter and gravity must have been everywhere the same, our contemplation comprehends a universe; for they, together with the wisdom by which they are directed, being the only principles concerned in the generation of physical things, the analogical relations of system with system must constitute one eternal unity, made up of an endless variety of magnitudes, motions, forms, and conditions of material substances. It can not be incompatible with this eternal unity, or be any violation of gravitating energy, that there should be an infinity of forms in the association of systems. The deducibility of double, treble, or quadruple suns to some of these is as much to be derived from gravity and its laws of action as that there should be but one sun to each system.

For multiple systems to circulate would only require a proportional extent of space for the exercise of their compound motions; for gravity could as easily govern suns with their compound associations of planets and satellites round one common center, as secondary bodies only. This force would, in every instance, determine the largest mass next to the center common to all, which would be that point where all outward attractions intersect in equilibrium, and around which they all would revolve. The motions of all the members of these compound systems would be as effectually secured by the combination of gravitating forces as are those of planetary motions in general; and the fact can be as well deduced from gravitating action as it can be ascertained from observation.

A question may arise, from whence could the luminous masses arrive? or where could they have been aggregated? Not, surely, in the same systems or spheres in which they now circulate, for we have already seen that such would have been impossible. But at the same time there is nothing impossible in their having had separate spheres of aggregation for themselves, from which, in the process of material adjustment, they were finally dislodged, and made to occupy a conjugate sphere. This is only what was to be expected, for during all the infinite period of the aggregating process the relations of bodies with bodies must have been undergoing incessant change. Indeed, their relative positions could have had no stability until gravity had finished its aggregating labor. We have seen in the first, or most incipient efforts of that force, that it must have been divided into an infinity of miniature spheres of action, each atom constituting for itself a center. These spheres would necessarily enlarge themselves as atoms impinged upon atoms; and as these substances further enlarged themselves by contiguity, so would their spheres of action extend. And this process would necessarily continue until all was gathered up and appropriated in their present associate conditions, the whole range of difference being from where each *atom* formed a separate sphere of action to where each sun now does the same thing.

This consummation must necessarily have occupied an immensity of time, and operated an infinity of change.

Present conditions are what we may call a consummation of the aggregating powers of gravity; but still that force is left as far unsatisfied as ever, for its whole effort, past, present, and future, is simply to reduce all matter over which it has any control to the occupancy of but one common center or point, and this really constitutes the law of all action, for, were this possible, gravity would finally have terminated its own existence. But this we may consider it has accomplished, as far as an eternity of matter and its impenetrability would permit. For as there can be no common center where there is no common circumference, the aggregating operations must necessarily have been divided among an infinity of detached masses; and even in them gravity can not accomplish its own satisfaction by any greater concentration than it has already effected. For as bulk is an essential characteristic of matter, a mass can not be made to occupy a point. Therefore the distribution of forces consequent on the infinity of matter and its massive parts, precludes the possibility that gravity ever can operate its own finality by inducing in these several bodies a consummation in rest, or any further conjugation in mass, to which its activity continually tends, but which as continually defeats its own efforts.

That force has faithfully executed its high commission, that is, so far as the formation and distribution of substances are concerned; so that we are now presented with the most sublime spectacle of a universe in motion by the simple action of energy, which has generated an infinity of worlds and systems of worlds, with all their complexity of kinds and characters, motions and magnitudes, in infinite association and variety. We are certainly now satisfied by what we have seen, that all this has been effected by the simple and immutable effort of gravitating energy at all times acting upon the atoms of a simple and immutable principle of substantive existence and character. Facts and inferences fully demonstrate the proposition, that it is the sole minister of Omnipotent Mind in the fabrication of worlds, suns, and systems. He only could have so adjusted its application to the material on which it was to operate, as to have made it productive of present conditions.

Had the application of this power embraced all matter indiscriminately, as physical speculators usually conjecture, operations would have still gone on to the extent we have contemplated, but with this very important difference, that the several material substances, in place of the magnitudes they now possess, could have occupied no greater extent of space than barely sufficient to contain their sensibly affected atoms.

Interstitial porosity could in no instance have prevailed, for all matter would, in such a case, have assumed the same stubborn solidity without any subsequent action or change save the circulation of their ponderous and profitless masses among each other.

It will certainly be safe to infer that Infinite Wisdom would not have occupied himself so unworthily as to have worked such a result, or the necessity for expansive or other forces by which such a consequence was to be obviated; and we may be sure that no agencies of his institution could have operated beyond or contrary to what was prescribed in the terms of their commission; and no commission could have emanated from him to effect what could have been defective, so as to require remedial agencies; and as there is no questioning the credentials of the gravitating power, as being commissioned by high Heaven, its functions must necessarily have been in perfect compatibility with the contemplation of a physical universe. Therefore to that force alone have we to look for physical development in all its forms, fashions, and phenomena.

Now, so far as we have yet contemplated the effect of this force, we have found it to answer all the purposes admirably. But we have only considered it with reference to aggregation and motion, and we likewise find both might have been equally produced were the gravitating attraction equally inherent in every atom of matter. (An opinion advocated by physical teachers, and that, too, in the ratio of their bulk, a property usually assigned them.) But as there can be no possibility of carrying out the order of nature in its more ethereal, active, and life-like phenomena by this species of its application, we will pursue our further inquiries under the assumption with which we set out, viz., that gravitating attraction, in place of being applied equally to every atom, was attached only to a definite portion of them, and to these with various degrees of intensity; by which provision and discriminating application, as directed by Omnipotent Wisdom, with whom the great physical scheme had its origin; we hold that all the phenomena of nature were made to follow; and this necessity is not only inferable, but conclusive, from the fact that matter impressed by that power (in furtherance of his own great scheme) with this gravitating attribute, must have been so affected with reference to all subsequent phenomena, and could not possibly have been a misapplication in the most remote particular. Its rules of restriction, therefore, with respect to extent and degree of intensity, must have been in perfect conformity with the designs of that Being who was so well qualified to determine what was right and required.

Chapter Three.

Design, how carried out—Effects of Gravity—Size of the Earth when first encircling the Sun—Different Forms of Solids, Liquids and Gases—Subtilty of Nature's Operations—Pressure of insensible Fluid—Its Agency in all Phenomena—Saturn's Rings—Comets, how Formed—Nebula.

SURELY none will question the existence of design in physical conditions; and if there be design, it must have been imparted to the atoms of matter which were to be the sole arbiters of such conditions; and this transfer of power must have been complete and perfect at the period when these atoms were endowed with that energy which made all action and motion subservient to a consummation of the whole physical scheme, so far as the force of that term will serve in such a place; for an absolute consummation or finality to physical conditions is no more compatible with the economy of nature than is absolute rest, which we have found never can exist among the physical creations. The particular details of this wise distribution of power among the ultimate atoms of matter in all its grades and degrees we may not be able to define, but we will endeavor to deduce from general action a recognition of the fact, and that enough of metaphysical matter has been impressed for all the purposes of physics agreeable to the Omnipotent plan, and that, nor any subsequent attachment of energy to metaphysical matter need be contemplated, as the scheme of physics must necessarily have been a perfect one when formed, or the wisdom of God was not infinite. We certainly have powers of comprehension sufficient to follow the action of this power with such accuracy as to understand the process by which it affected phenomena in general. We have already traced its action in the transfer of atoms, and the formation and association of substances and systems. But at the same time we have found that all these substances are in reality very far from being what it is supposed gravitating energy would have made them; *i. e.*, substances of perfect solidity. At least they are not now what our senses call such, for our experience would seem to prove all substances to be but a physical framework for interstitial vacuities.

Let us now endeavor to deduce how this energy, in its assorted order, could have effected the phenomena of nature. Granting that the separate atoms of matter were unequally endowed with the gravitating energy, who can calculate how far their combinations could be carried out? Its first effect would be to make nuclei of these atoms most liberally endowed, around which others less affected would concentrate in spherical masses, of whose extreme minuteness we can form no conjecture, though perhaps composed of myriads of gravitating atoms, besides the intermixture of those not at all affected by that force. For in the feeble efforts of incipient action, we do not suppose all such would be at once excluded from these first formed or forming spheres. In these incipient formations there could have been but little diversity of character, circumstances only varying by a simple modification of the force by which they were formed. The constituent atoms of these primitive spheres must have arranged themselves round their center in the ratio of their force, consequently would have decreased in gravitating energy from the central atom outward by stratums of less and less affected atoms. This fact is deducible from two obvious circumstances: first, the greater energy would not give way to the less, in determining their relative positions around the common center in the formation of sphericals, those that were the most energetic taking precedence of those that were less so; and, second, that every acquisition to the sphere would so augment its attractive powers, as to have effect on atoms of still more feeble energy that could not in their positions have been acted on, except by such combination of force. Thus the denser or most gravitating atoms would occupy the center, and those of the least specific gravity would form an atmosphere over all.

In the most simple and incipient efforts of gravitating action, therefore, such must have been the character of the first molecular formations, and they must have been perfect in structure with their constituent matter progressively diminishing in ponderosity from their centers to their circumferences. We can make ourselves sure of this universal form of structure, even though millions and millions were required to make a visible particle, so that the form and character of the most fundamental molecules are more susceptible of demonstrative construction than substances that are appreciable by our senses. Now the force which so necessarily formed these primary spheres would as surely cause their coalescence; but by that it would by no means follow that their constituent molecules, by becoming confluent in the general mass, would not retain their own forms, for primary globules made up of ultimate atoms of *unequal* energy would necessarily arrange themselves agreeably to that energy from the center outward, which future combinations or conditions could hardly subvert, for these atoms could not flow together in the formation of any more massive substances in abnegation of their own forms, because the less ponderous atoms of their circumferences could no more penetrate to the *center* of those contiguous than they could to their own center. The lighter atoms of the surface could not displace the heavier ones of the center, neither could they frustrate contiguous sphericals; but while the lighter atoms could make no progress inward toward the center of such molecular sphericities, their combined energy would effectually retain all inferior to themselves in their relative positions, so that their individual nucleus atoms would be unable to change their place. These central atoms could no more migrate into other spheres than could the suns of the different planetary systems invade each other's dominions. Gravity governs in both cases, and its action is always the same. It began with the formation of matter into miniature spheres, and has terminated the aggregation in spheres of immense magnitude, while the primitive formations may remain as at first; they were the first effect of gravitating energy, and nothing could have disturbed their primitive structure. It is highly important that a proper appreciation may be had of all the facts in these first forms, for they are not only highly typical of all formative character, but they are the very rudimental forms from which all else is constructed. Spherical formations, or an effort to that effect, is unquestionably the never-failing order of physical action, from the primitive molecule to the ponderous mass; and at no period could physical energy have effected such formations in greater perfection, and with less embarrassment or in greater stability, than when the atoms were in single and unobstructed obedience to its will. In the most incipient order of nature all energetic matter must necessarily have taken this form, whatever the order of energy by which it was impressed, and every atom of such matter must either have constituted a nuclei for such formations or have associated themselves therewith; for the idea of an energetic atom remaining neutral among its fellows would be an absurdity. The very first effect of gravitating action upon material atoms would be to produce motion, the second would be the formation of separate and distinct spheres, and the farther progress of aggregation would be the gathering together of these rudimental sphericals into larger and constantly increasing masses; but no accumulation of them would materially change their structural formation, unless by the compressive effect of all as seeking their common center. Primitive atoms being impressed with various grades of the attractive energy, and under multiplied forms of intermixture, would necessarily originate these molecules with as many different grades of intensity, for this would depend on the energy of the atom at the foundation of the superstructure or foci of the spherical, for no atom could maintain that position unless those around it were inferior to itself in energy, at least not exceeding it; for there may be in some instance more than one atom equally forming the nucleus of these ultimate globules. But while we perceive that in these primary formations their nucleus atom or atoms could not be surrounded by others of greater ponderosity than themselves, we may with equal facility perceive that atoms of any degree of energy might constitute nuclei for such formations, they being still in progressively less grade than themselves. The energy of the aggregates therefore would be in relative value, as the central atom round which they were formed, and their respective forces would be as much diversified.

Seeing that every atom of matter over which the attractive energy could have had influence, must necessarily have been forced to form a component part in these primary formations, we thus arrive at the very important fact of their being the only ultimate molecules of which all the rest were formed, and all other things made. And there being nothing but ultimate atoms for both base and superstructure of these first formations, and but one species of energy affecting them, they could not possibly have been otherwise formed than as above indicated, and certainly most admirably calculated for the further development of physical progress and the formation of all other substances; for though simple atoms would be unable to effect any thing but molecules, these by their qualifications would be able to effect an infinity of formations, but progressively becoming more subject to mutation. For as the variable intensity of atomic energy qualified them for their first formations, they, in their turn, by their variable intensity, would be as well qualified to constitute both base and superstructure of all other molecular formations; for by the simple repetition of the same process as that by which atoms were multiplied into initial magnitudes, these in their turn, and by the effect of their aggregate energy, would inevitably be erected into other spherical molecules of secondary character and more massive proportions, but not by any intermixture of their constituent atoms; for there could be no disposition, as we have already seen, in the atoms of one primary spherical to invade others similarly circumstanced, neither could these ultimate forms invade each other, however closely compressed. Even the most ponderous atoms of which they were composed could not possibly leave their respective stations in their own spheres to circulate through others in search of a center of gravity common to all, because the effect of the surrounding atoms with whom they were constituently associated would forbid their separation. The energy of the constituent atoms of these primary spheres would as effectually secure permanent relations among themselves as does the influence of the solar system secure the permanence of its component members. Each being equally subject to the same law of action, must necessarily exhibit an analogy of conduct, the only important difference being, that one is the first fabric in the progress of aggregation, and the other its completion; and that the matter of all the most extensive aggregates are under vast compression and consequent solidity, while the aggregating process was conducted by forms the most perfectly fluid and free in action.

Such is the process of deduction by which we are enabled to demonstrate the character of primary formations consequent on the inequality of energetic action upon atoms, and the formation of these first fabricated sphericals into other globules of compound character. We can not form an adequate conception of the infinite interval or progressive term that must have intervened between the condition of matter as an atom emanating as an essence of the First Cause, and the manufacture of magnitudes that are measurable by our finite powers. From an atom to a sensible substance comprehends such minutiæ as would undoubtedly involve millions of structural formations; and as atoms are in their own nature immutable, every degree of magnitude, from the primary molecule to the largest mass, could only be effected by their aggregation and combination in contiguity. This is the grand process by which nature effects all her phenomena—not by vacuities or the resolving of interstitial spaces by repulsive forces, but by matter differently disposed in its attractive affinities.

When this grand primary process of physical action is better understood, there will be less difficulty in explaining the origin of phenomena and their susceptibility of change. We have seen that primary forms must have been made up of atomic numbers decreasing in energy from their center to their circumference; we have seen that secondary formations must have been constructed of these primary ones with like diminution of their energetic intensity from the center outward. Masses of such aggregated sphericals, with their external or atmospheric matter lying thus lightly and loosely, and with an almost infinite susceptibility of motion of the atoms round the respective centers of ultimate forms, and these ultimate forms again round the centers of compound molecules, would cause the very perfectibility of fluid action only when under vast pressure of impact. While we thus so clearly demonstrate the fluidity of all active matter to have been the necessary consequences of the attractive energy of its own atoms, we can perceive no necessity for any repulsive agencies of which we hear so much. And as we at the same time repudiate the idea of any other existing power or species of energy whatever, it may be as well to signify how matter could assume other conditions besides solidity. In so doing we have only to observe, that in the grand and final aggregation of matter into the masses forming our sun and planets, the impact or compression to which these fundamental globules would be subject, while seeking their common center of gravity, would necessarily be a cause of much modification of form, the nature of which we will hereafter consider.

In these massive aggregates forming from such a system of perfect fluidity, it certainly will not be difficult to perceive that those fundamental molecules that exercise the greatest degree of energy would, by virtue of that energy, be the better calculated to urge their way, and would thereby advance toward the center of that mass of which they formed a part, until its accumulating quantity had caused such solidity as precluded their farther progress downward. These forms, bound together by their own special affinities, could not have been subject to any infraction of their constituent nature while thus descending through the midst of others of kindred character, as the similarity of each to each would prevent the destruction of their individuality; the attractive powers of every constituent atom and molecule of a mass being so balanced in their formative characteristics as to prevent all tendency except to the common center. But while we infer such a condition for all matter, it may seem that even the tendency of our deductions is to bring the effect of all action to a rapid termination, for one exclusive tendency seems but ill-qualified to effect general phenomena; but of that we shall see. The inference is unquestionable (when we reason from our attractive premises), that when *energy* was effecting the aggregation of ultimate atoms, and therewith forming fundamental molecules, much feebly affected matter must have been drawn around them; and as the secondary molecules succeeded in their formations, the combined energy would have still greater influence in appropriating such matter to their mass; and as these globules coalesced in general aggregation and compression, much of their individual atmospheric matter would be pressed out and left on the outside of these compound spheres, which, in passing through space, would aggregate and attach to themselves the outfloating atoms of the most feebly energetic powers.

And as sphere coalesced with sphere, all this lightly affected matter would be excluded by compression, and by the more energetic having preference of place toward the common center, so that the least affected matter would envelop that of superior grade; thereby an immense quantity of this feebly affected matter would thus be aggregated round the more energetic portions, which would, for a time at least, continue to form the fluid or semi-fluid nucleus of the whole.

Now this insensible portion of active matter, which our powers can not appreciate, must be incomparably the greatest portion of all, for it enters largely into the composition of every fluid substance, and completely fills the interstices of all solids, besides constituting many important substances that our senses can not recognize, although from them they may receive their vitality, and be the very conditions by which mind and matter in its sensible forms are associated; as it is evident there is an intimate connection between mind and matter, this insensible substance is the very medium by which this intimate connection is effected; and as we become better acquainted with these insensible substances, we will see how their activities are appropriated to the most valuable purposes of life; and perhaps mesmerists and spiritualists may find how far this medium is effective in their phenomena. This insensible matter not only forms a great part of fluid substances, but must enter largely into the most solid portions of our earth, as well as of all other massive solids, but it could not continue in the same relation after matter had solidified that it occupied while all matter was fluid. As the particles of matter solidified, the insensible or less affected matter of the envelopes surrounding each molecule, and unsusceptible of solidity, would be forced to fall into their interstitial spaces among the solid cohesions. Thus we have found the process to be both simple and evident by which fluid masses were formed by the attractive energy *alone*, and without any necessity of repulsion or polarity of forces being called into action. We will now endeavor to demonstrate the nature of the circumstance by which the solidity of matter in its many conditions is made the secondary effect of the same active principle as that which resolves fluidity in all its forms although it may at first seem very unlikely that the same force should be effective of conditions so very different; and in contemplating such important phenomena from their inception, we will consider the aggregate quantity of matter in the mass of our earth to have been about two thirds of what it now is when it first encircled the sun, for more than that it could not have been, as we shall abundantly see when we come to consider the cause of the earth's geological character. Now two thirds of our earth, in what we may consider as cometic, gaseous, or semi fluid matter, must, in the whole, have been of vast magnitude, and the initial molecules forming its nucleus must have been under immense amount of pressure because of the incumbent matter, sensible and insensible; that magnitude being wholly made up of matter of different grades of energy constructed into molecular globules, the most energetic of which would be next the general center, because of their specific gravity, while the whole substance was yet in a fluid state, this mass could not (as is usually conceived of such bodies condensing into solidity) have contracted its dimensions even to the value of one atom, all being matter of some sort occupying its initial extent of space. But its component molecules could not have preserved their former magnitudes, but must necessarily have undergone much modification incident to the immense pressure to which they would become more and more exposed, for such impact or compression would so derange that perfection of molecular sphericity in which their affinitive relations had formed, balanced, and preserved them, that these mutual affinities of their constituents would no longer maintain these forms in their primary integrity and relative positions with respect to each other, but would permit their respective central forms to exercise their more effective affinities for each other, by which they would be divested of their less energetic atmospheres, and made to shoot in the least obstructed direction into contiguity with each other in the formation of crystalline needles, connected by points of contact bearing but small comparison to the place occupied by their former exterior matter. Their atmospheric envelopes thus left to occupy the interstitial spaces would again form other systems of spherical globules among themselves, having less tendency to solidification by being either altogether insensible, or becoming sensible under a different order of circumstances, the operation of the attractive energy permitting no portion or particle of effective matter to remain unoccupied in structural formations, by which alone the affinity of parts is satisfied. Now these solidifying molecules thus denuded of their atmospheric envelopes by impact, would be no less fundamental than at first, their nature having undergone no change, but being rendered more energetic by the reduction of their less energetic exteriors by pressure, and were the pressure removed they would again be as before; for the sole cause of the exhibition of matter under the different forms of solids, liquids, or gases depends on the liberty which energetic agency has to exercise its functions freely in the formation of spherical globules in their unrestricted enlargements, or by its being more or less subject to the restrictive force of pressure caused by its own aggregating act. Hence we perceive that gaseous fluidity is the only direct effect the attractive energy could have upon matter. All other conditions must necessarily be but the result of secondary circumstances, such as pressure, etc., and the consequent improvement it would cause. The most effective is the pressure such energy would occasion, even from the incipient impact of the central atoms of the first-formed molecules to the ponderous pressure of the last mighty sphere. But the degree of impact agreeable to this simple rule of nature would not be in the ratio of quantity superimposed, but of the energy exercised by that quantity. Hence ponderosity is no measure of the quantity of matter in a mass, but only a manifestation or measure of the energy of that which is sensibly effective. There being no limit or termination to matter in either direction or distance, outside or inside of a visible mass, all quantities are necessarily equal in equal spaces, but at the same time very unequally conditioned.

There is, as we have before stated, in abstract matter, no difference in either quantity or quality, nor is there any intervening space, nor any necessity, or even possibility that there should be any, for all the purposes that could have been contemplated in the physical scheme, as all the phenomena of nature could be so effectually, simply, and beautifully brought about by the judicious application of that energy contemplated in the counsels of Heaven, and caused to be effective upon matter for the furtherance of physical economy. When we reflect that the mass of our earth was by this energy aggregated, and her structural formations thereby fabricated, and infer from circumstances deducible therefrom (which will abundantly present themselves in process of research), that the quantity of insensible matter even in the construction of our world exceeds by far the solid or sensible portion, we shall have but little difficulty in ascertaining the cause of the infinite phenomena of nature. As an example both of facts inferable and of the slow progress of their deductive or inductive evolution, unless they are palpably indicated or made plain by our senses, we will here observe that mankind were, from the very earliest ages, aware of the existence of our common atmosphere; but it was not until a comparatively recent period that the discovery was made that the atmosphere had either weight or pressure, a circumstance that had not even been previously thought of, notwithstanding the phenomena necessarily consequent therefrom had been both an evident problem to be solved in philosophy, and a fact appropriated to the useful purposes of life. And though the fact is well known now to all, still some minds find it difficult to realize, because it does not address the senses directly.

But surely it would be unbecoming the philosophic mind to suppose nature ceases her operations because our senses fail to observe them, for in no single thing that comes under the cognizance of our senses are we able to recognize either the inception or the process by which it is evolved. All of nature's operations are in their processes conducted with a subtilty and secrecy that completely baffles our senses, and it is perhaps well for us that they should, for as we are situated in the very midst of her great chemical and formative laboratory, it could not be for our comfort to have senses of recognition beyond those which we possess. But from the matured phenomena with which our senses make us familiar, or in the subtilties in which they originate, we have no cause to conclude that the whole of the effective matter comes under our sensible recognition; and we have certainly demonstrated that even in the visible mass of our globe, where our senses make solidity so essential an evidence of materiality, and so, likewise, of the other heavenly bodies respectively, there are envelopes of insensible matter of unquestionably far greater quantity than that which constitutes their solid nucleus. And such is not only the nature and quantity of their exterior and invisible matter, as constituting their envelopes, but by far the greatest part of their visible magnitudes are likewise occupied with matter of a character of which our senses can take no cognizance. The appreciable atmosphere of our earth is all that is now known or admitted to exist exterior to her solid surface. (Our senses, at least, do not inform us of any other.) But this gives us no right to conclude that it is the most exterior matter of the mass having activity. Although this atmosphere is a sensible substance, still it is one of considerable subtilty, and not recognizable by sight, nor readily appreciable by any other sense when in a passive or motionless state, notwithstanding its weight is ascertained to be about sixteen pounds to the square inch.

Now how is this fluid formed, when a column of it, supposed to be about fifty miles high, weighs only sixteen pounds to the square inch of its base? Not, certainly, our senses would say, as a connected continuation of atom with atom, and, indeed, so do philosophers; but as neither the testimony of the one nor the opinions or teachings of the other are regarded by nature, nor by us, as being a law of action or rule of physical conduct, we will proceed on that principle which we have assumed to be the order by which nature effectuates all her formations, particularly of gaseous substances. None of the existing hypothetical systems recognize more matter than what is embraced in the appreciable constituents of any gaseous substance as being at all essential to the formation of said gases. The quantity of matter in our atmosphere, for instance, is supposed to be measurable by the weight of a column one inch square and fifty miles high—that giving sixteen pounds of oxygen and nitrogen, supposed to be the sole quantity of matter employed in its composition; the usual doctrine being that the repulsive energy of that much atmospheric matter makes it occupy that much space, as if so little matter distributed in so much space was meant only to serve as points of attachment to which the attracting and repelling energies should fasten themselves; and that the atmosphere, or any other gaseous body, is not material only to the extent of these attaching points, the balance being a complete tissue of metaphysical network, which, as we have seen, can mean nothing, repulsions being, if not inconsistent, at least altogether inapplicable to matter. This doctrine is but little in accordance with the conduct of nature's omnipotent attraction, which makes these sensible constituents but the base round which to arrange so much sensible or insensible matter in virtue of its own inherent energy, which often makes this sensible quantity seem to occupy so much (of what we would call unoccupied space, if we could indulge in so absurd an idea). This association of the sensible with the insensible in gaseous or atmospheric formation is certainly none the less an effective material substance, because most of the matter when decomposed is subject to no physical test that we have it in our power to apply, to ascertain its relative value; and though these gaseous substances are susceptible of indefinite compression by impact, we are altogether insensible to the excluded matter only by the reduction of volume, which is again resumed by the reduced molecules on the pressure being removed, and this because each constituent molecule of the sensible quantity would be in the same condition to resume, as it was in the first place to form the bulk of its spherical constituents from this quantity. Although this atmospheric exterior of our earth's solid surface is made sensibly effective by so small a portion of ponderous matter, or of the energy that makes it so, as in the whole not to amount to more than one ounce and a fraction for each cubic foot, and that only in its most dense under stratum, still this gives us no right to regard this as the measure of the whole quantity of effective matter really constituting the mass. And we conceive it would be far more consistent with the character of Omnipotent Causation to infer that sufficient energy had not been imparted to this matter to make it sensibly appreciable by us, or in any measure more effective than it now is, than to suppose the great bulk of this atmosphere to be made up of mutual repulsions among its recognized molecules, and they mutable in their application, and polarizing in their effect. This ounce and a fraction to the cubic foot is only to be taken as indicative of the sensible relation of energy to quantity as respects the bulk of any mass. There can be no measure to matter when considered abstractly, save the eternal immensity, and that is obviously measureless, for it must necessarily have an omnipresence equal with the Author of that energy by which portions of it have been variously affected for the physical purposes thereby intended. Such being the true condition of things, very much of the solid and sensible part of our globe must necessarily contain very large quantities of the insensible matter, for the interstices of all apparently solid substances is well known. Indeed, these more solid and sensible portions are but the partition walls or skeleton framework of substances in whose labyrinthine cells this insensible matter is insinuated in one unbroken connection of sympathetic susceptibility. The mutual effect of the attractive energy, even delicate as that must be over this internal and ethereal matter, would permit no portion, particle, or atom to remain unoccupied in structural formation, however insensible such formation must be, for this affection having attached to them, the constant affinity of parts could not remain an instant from an effort at being satisfied.

Now, although our earth and its atmosphere are the receptacles for such an immense mass of this invisible matter, such certainly does not signify that they contain any thing like the quantity that belongs to our globe, for if it was primarily so prevalent and diffuse among more energetic matter, we may safely infer that much of it must have been left outside the aggregating bodies both in their miniature and massive constructions, they being indeed but the nucleus of their vast though invisible envelopes. In the immensity of this ocean of inappreciable matter around the solid nucleus of our earth are all visible things pertaining to it immersed, and at a vast distance from its exterior surface which finally passes into perfectly passive matter, or that matter which has no species of energy attached to it, never having been affected from its metaphysical condition. The extent of this effective though insensible envelope is to be inferred from the fact, that the fundamental spherical molecules that formed this solid nucleus were externally furnished with not only as much as occupies the interstitial cavities, but likewise with much that must have been expressed by compression of the whole gravitating to a common center; for if such was its relation as to quantity in these miniature globules of comparatively feeble energy while under no compression, what may we expect to be its relative quantity around the solid nucleus of our earth with its combined powers for such a concentration. The sensible atmosphere certainly bears but small proportion to this vast envelope, for it is estimated not to exceed fifty miles in height, and to diminish progressively in its density from the earth's visible surface to nothing at this elevation; and yet it acts upon all substances at that surface with a pressure of sixteen pounds to the square inch. Now as such is the condition and effect of this but slightly sensible fluid which forms our atmosphere, and which is of so comparatively small extent, what may we expect from that vast ocean which we maintain and demonstrate must encircle our earth, and in which the sensible molecules of our atmosphere and all other gaseous substances are suspended and associated in formative solution? May we not consider it as enveloping the visible portion of this earth at a depth and pressure of many thousand atmospheres, although its nature and condition preclude the possibility of its being sensibly effective upon our perceptive organs, or subject to any test in our power to apply? This will not be considered as a gratuitous assumption thus to promulge such an existence, for it is clearly deducible from the elements we assume to be effective of phenomena; besides, we shall find abundant evidence of its effect in the generation and resolution of all physical phenomena that our senses have power to appreciate, insomuch as there is not a visible thing of which it is not either the primary or proximate cause. Indeed, such is the character of this vast ocean of invisible and imponderable matter, that it has either given birth to, or is pregnant with, every phenomena of physical visibility, and without it the whole physical scheme would have been a failure. It is the great reservoir of nature, from which she derives the forces and the materials for the formation of every visible thing, for none of the affinities of matter have force sufficient only under such pressure to form a solid, a sensible, or visible thing. It is that very condition of matter alone which she could make effective in bringing its forms forward so far as to be what they are, and within the scope of what our perceptions recognize as matter, and further than this, we find she can not make such appreciable matter, at least of a solid character, further effectual, without undoing such sensible forms as she has thus made, by resolving their matter back into this vast ocean of invisibility from which they originated, and from which remodifications are produced. This process of reduction is at least required before there can be a reproduction of animal or vegetable substances.

By this sure system of reasoning, it is clearly perceptible that the constituent matter of the most solid portions of our earth must have received the impress of its character while forming part of this vast ocean of invisibility. All the visible and solid forms of matter are necessarily the final (to what we might call an infinite) series of its formation, at which the attractive energy ceases to be further effective, except for their preservation. We are therefore compelled to consider this invisible ocean as the great and prolific laboratory and workshop of nature, within whose precincts she prepares and reserves her materials ready for the development of her more palpable productions, which consequently embraces a term of physical preparation of no ordinary extent, having its beginning in the infinitesimals of matter as emanated by Omnipotence, and its termination carried out into the sphere of our perceptive faculties. So therefore as the finite is from the infinite, so must this vast invisible range of structural formation be, before matter can be evolved into visibility; and such must necessarily be the character and composition of this vast enveloping medium that surrounds our earth. And as our perceptions of matter are confined to its condition at the extreme or final of physical effect, they certainly can furnish us with no criterion by which we can judge of its quantity even in an effective condition. And we must perceive that such as is within their scope must be but ill-qualified for the evolution of active phenomena, and but comparatively an inconsiderable portion of the great whole, which must, in virtue of its attractive affections, be formed into an infinity of molecular formations of such grades of character as is most conducive to the development of physical conditions, and the evolution of all the important and active phenomena known as heat, light, and electricity, of which so much has been said and so little known.

We have now followed the effects of gravitating affinity, particularly in the formation, condition, and character of these vast envelopes that must surround every extensive body, so far as will enable us to return to the consideration of how that force could have furnished the planet Saturn with his massive annular appendages encircling him in unbroken continuity. These are unusual, and difficult to be accounted for by the laws usually supposed to govern planetary motion. Conjecture has taxed its powers inconclusively in attempting to make the motions of these associate masses comport with the conditions of these assumed laws, so as to insure to them their permanency of relative place, against the power, condition, and position of the mass they encircle. They are known to preserve their respective distances from the planet's surface, but by what means is yet a comparative mystery. It is supposed they must have been balanced with an initial nicety of the utmost precision, to have enabled them to maintain their position through all their revolutions. What caused this matter to take forms so peculiar and contrary to that of masses in general, or how they came to be projected with precisely the same velocity as the body they encircle, why they encircle that mass at all, or how they are annular while that body and so many of its associates are spherical, philosophers have failed to give or even to imagine a philosophic explanation. They can not possibly deduce such conditions from their adopted laws. The primary impulsion so essential to their motal system is derivable from none of them; neither is that initial adjustment, in all the nicety which they are so ready to attribute to planetary bodies, at all deducible from their physical laws, and it is certainly incompatable with true philosophic thought to entertain or inculcate the doctrine of direct impetus and adjustment being communicated to planetary masses by a special act of the great Originator. Were such a case possible, it could not be called the result of a physical law, but the special act of the lawgiver. We have already fully demonstrated that every visible condition must have been affected by physical agency, and not by any special or final effort of the great First Cause. What are universally received and entertained by physicists as the laws of motion, are *not* those by which the planets or satellites revolve, or Saturn's rings are urged onward in their orbits, or sustained in their social relationship. Therefore there need be none of those fears entertained for their stability which we see so often indulged by those who cultivate the idea of primary impulsions, and first, second, or any other series of motal laws that have been conjectured; they not being in the system of things can not be responsible for the permanency of motion; and what is really the system of things will rule their perpetuation, or the Originator could not have been right in their adoption.

We may rest perfectly assured of the fact that nature nowhere relies on the rule that can by any possibility cause such a condition of things as would call for any special act of conservation against casualty. For in every department of her universal empire, she has all necessary conservation in the conduct of that sovereign law by which her infinite phenomena are evolved; were it otherwise, a want of wisdom and immutability would be evinced in the Source from whence that law emanated. This is the grand criterion by which we can safely judge of nature's primary laws; all which will not stand the test of this rule, but is found in any particular changing or flinching from their integrity, must be rejected as unworthy of such a consideration. The laws which philosophers assume for the motions of planetary masses being of such a character as to create fears for the permanency of systems, and more particularly for Saturn and his rings, must necessarily be erroneous; for it is evident, as they suppose, that were any force to affect either him or them, incompatible with these assumed laws, their motions and relative conditions would either be permanently changed or totally extinguished; for these laws are of such a nature as not to admit of the least infraction without begetting a corresponding derangement in all they are supposed to rule. As, for instance, were Saturn or his rings to receive any new and unequal impetus from any source whatever, which is certainly a very possible contingency, and one that must have already occurred hundreds of times, agreeable to the initial and inertial doctrine, there being no nullifying reservation against such new and extraordinary power, they would, as a consequence, be urged onward with unequal speed; and one being inclosed in the plane of motion by the other, they would be unable to part company; and seeing they could not separate, and their rotations being unequal, would produce such a ripping and grinding as would cause the total devastation of both planet and rings. Now to attribute to nature any system of ultimate law that would lead to or allow of, any such a consequence, is certainly preposterous in the extreme.

But this is useless speculation; for we will presently show that there does not exist a possibility by which such a casualty could happen. While it is impossible, and altogether inconceivable, how any plurality of planetary impulsions, or motal law, could either resolve their complicated motions or insure their perpetuation, it is very comprehensible that by the effort of one grand and eternally active unity there would never be either conflict or casualty. There is no other alternative for the physical contemplator than the conclusion that Saturn and his seven globular consorts are united by token of his rings in one eternal tie of affinity, with but one function or force, so of course there could be neither disruption, divorce, or abduction among the members of this family thus socially united.

Now by following the effects of the gravitating affinity of matter, we have seen it pass by a grand series of spherical progression from its ultimate atoms as emanated by the Almighty, to the final magnitudes as comprehensible by man. By the evident and inevitable conduct of this same aggregating affinity, with its wise distribution among the atoms of matter, we have been enabled to perceive how all the planets, satellites, or other secondary bodies were concentrated in massive quantity far remote from, but somewhere intermediate between, the grand solar centers, and without being thereby absorbed; but to which, in obedience to their superior attractions, they were subsequently made to descend in their relatively approximate orders. We have been able to deduce that the native forms of these bodies were spherical and their first conditions fluid; this was the necessary condition of every aggregated mass, and the rings of Saturn could have been no exception to this general rule, as an infinite multitude of sphericals were aggregated sufficient to form the ring, and this globular mass making its way into our system (in obedience to that system's central force), would pass the orbits of Neptune and Herschel, while these planets were on their periodical pilgrimage far remote from the place where it crossed their paths. But in its onward journey it came nearer to Saturn, whose attractive rays were of sufficient force to fasten upon this falling body and make it follow him; and this attraction increasing in power in the direct ratio of the square of the distance descended through, would force the body to fall with vast velocity, so that when it had gained such proximity as to be immersed in the circumambient ocean of insensible matter that forms the exterior envelope to Saturn's sensible mass, it would thereby be reflected outward at some certain angle; being in relation to velocity and the density of the reflecting medium, a balance would be made up between the attractive force and the reflecting fluid, so that the body would pass round the planet into its own path, in place of impinging upon its surface, which their unresisted affinity would have caused it to do. It will be easy to perceive what would be the necessary consequence to a fluid mass of globular form thus passing with such rapidity through a fluid medium with far less motion. It is certainly evident that the less dense exterior of such a falling body, in consequence of being both more readily resisted and less attractively affected, would soon be left far behind the careering velocity of its former nucleus; so that the body itself would soon be reduced, and made to assume the phase of a comet with a rapidly elongating tail. The center of the mass being of greater density would project itself more rapidly forward, and, being less subject to dispersion, would longer resist the disintegrating effect of the medium in which it had its motion, and thereby make the circle of the planet in less time, consequently overtaking and passing into its own matter. The process of dissipation being thereby accelerated, its nucleus would make but comparatively few revolutions in its own and the planet's matter before it would become totally dissolved in the general mass of its own circular extension.

We can conceive of no condition of things better calculated to cause the reduction of a globular body, particularly of a fluid or cometic nature, than by the dispersion and distribution of its matter into an annular mass, than would be furnished by the velocity of such a body falling into and forming a very contracted orbit round and in the midst of the external and resisting matter of such a body as Saturn. While this globular body thus intercepted on its descent from outer space was in process of progressive transformation into a ring, the attractive force by which it was made to fall and perform its first orbitual revolutions round the planet would become as progressively and perfectly distributed round in this new formation, consequently its disposition longer to urge or sustain circular motion would necessarily depreciate down to a nullity, by the relative attractions being thus resolved into but one common center of gravity for both planet and ring. Still amid all this the ring would not cease its rapid motion round its own center while in a fluid state, otherwise the most ponderous matter of its mass would have been precipitated upon the surface of the planet. Saturn's more ethereal matter would not have been at all qualified to sustain such a burden, which, on first being spread out, would not have the self-sustaining solidity of an arch, and must have been always in motion. Seeing, therefore, that rotary motion was essential to the very existence of such a ring, and that it originally derived such motion from orbitual impetus, or the effect of gravity upon its unequally distributed matter while the ring was in process of formation, and that such cause of rotation must have become progressively less and less effective, until its action was altogether extinguished by the perfection of its annular formation, we must, therefore, look to some other cause for the mass still continuing its revolutions around Saturn. In the first place we have seen that while the mass continued to retain any portion of its globular structure disintegrated, it would by the attraction of the planet be made to revolve round him, as his other satellites do; so in the second place we can perceive that as this mass was dissipated by the action of the medium in which it revolved, and its matter elongated out in its own orbit encircling the planet as an annular mass, its rotation would be continued by the effect of solar attraction acting with its unequal intensity across the diameter of this circular body, as we have found to be the case with planetary masses of spherical form, whose rotary motion are both begun and continued by this inequality of central force acting across their forward motions.

While this transfer was being made from the generating to the perpetuating power, the matter of the mass would undergo such measure of modification in its motion, as was the difference between the transferring forces by which it was primarily and subsequently impelled. We find little difficulty in perceiving that the resisting exterior of Saturn's mass, into which this body had been made to fall and form revolutions, would necessarily reduce the velocity occasioned by the falling force while forming the ring; so that the solar attraction would by itself be able to take up and continue the rotary velocity to which the mass had been reduced, by the progressive equalization of the planet's attractions, as they were made to take effect round a ring, for this formation being round the body of Saturn, and of equal density and distance, every part would be affected alike, there being but one common center of gravity for both.

Now there certainly is in these conditions all the requisites for the formation and eternal duration of this social compact between Saturn and his rings, which no force ever could or can permanently disturb or nullify; for any power that could derange this equipoise must be an over-match for the planet's attractions. To remove their centers of gravity from the same point would, in a great measure, be equal to the elevation of as much of the mass of the ring as would be more than a semi-circle above a plane passing through the planet's center of gravity; for as the center of the ring was removed from the center of the planets, so would be multiplied the infinity of attractive points radiating, as it were, from the planet's center to what was more than half the circumference of the annular mass, while the diminution of force on the other side would be in almost equal ratio. Such a condition of the planet's force, as applied to the ring, would certainly restore the former relations so soon as the disturbing force should cease to act. The whole circumference of the ring being equally affected by the attractive affinity for the planet, were it even possible for any power to cause their contiguity at any point, by depressing it upon the planet so soon as that power had passed away, the depressed side of the ring would at once resume its former position in consequence of this multiplied exposure to one side of what was their common center of attraction; this is readily reducible to mathematical demonstration.

The rule of action by which the rings of Saturn are made to occupy a place equidistant from his center, is of the same character with that by which solar masses are sustained in their several central positions, only the forms of action are somewhat inverted, inasmuch as in one case the solar bodies are restricted to the occupancy of the centers of vast spheres of attractions operating on them from without, while, in the other case, the position of the annular body is at a certain spherical distance from a great center of that power, operating on it from within. If conditions indicate the law in one case, the same law is equally to be inferred from the other; and here, in both cases, conditions are certainly in the most perfect accordance with the action of gravitating energy. And if that power can, acting from without, disturb at any time the relation of Saturn and his rings, it can as surely, acting from within, render a complete restoration. The same rule that resolves the formation and position of one ring would be equal to the formation and government of a series of such. But their position, with respect to the planet and each other, would depend on the measure of resistance which impact would interpose to their passage. The first ring was compelled by this power to its place at a certain distance from his visible surface, for by the force of its fall (reflected from the concentrating compression of the matter of the mass to which it was descending) it derived its form and first motion.

In virtue of this position of the first ring, and its superadded attraction and insensible atmosphere, the quantity and compression of Saturn's insensible exterior would be so much increased and extended beyond, and in the plane of the ring, as to reflect, at a greater distance from him, any other falling body; so it would occupy an exterior position by so much intermediate space as would be the effect of the force in the formation and position of the second ring. By this circumstance of a second ring we may readily recognize the possibility that this process of annular formation in a series could have been continued so long as their superadded insensible contributions could sufficiently extend the reflective force as to resist contiguity of the sensible quantities; but the progressive diminution of this reflective ability being inverse as to distance, the reflection in one plane of such annular masses could not have been many or distinct.

Now we think these rings of Saturn prove, most conclusively, the existence (and outward extension from the earth and every other globe) of an immense ocean of matter, unappreciable by our senses, yet effective of phenomena, and under vast compression by its own incumbent weight; for we can not see how, in any other condition of things, these rings could possibly have originated. But whatever may now be the character of the phenomena of which these circular conditions are the great physical expression, it would seem as if their constructive powers for investing planets with such annular appendages is suspended, either by the inefficiency of its own action or the inaptitude of the objects on which it has to operate, for it now makes no such disposition of matter, although we may frequently find (that by the affinity of our system's common center of gravity) masses of various magnitudes and apparent density are still, as before, made to approximate so close to some of the great family circles of our system as seems to challenge a more social fellowship, or a place with them on terms of a more intimate attachment of perpetual continuance. But these bodies are all sent back from whence they came, without being able to effect the change they seem to seek, the matter of these erratic bodies that are still permitted to wander, and that our system's members fail to bind in more close fellowship (being the last, because the least energetically affected matter), still finding what we may call independent isolation in solar space, all bodies having matter more energetically affected being already, as we have seen in the asteroids, made to encircle our sun in orbits of much less eccentricity.

Now the very circumstance of the many comets that have been from time to time penetrating planetary space, passing inside their encircling orbits round the solar body, and back to whence they came, without either being appropriated as planets, satellites, rings, or precipitated on their surfaces, or on the surface of the solar body, is certainly significant of some great physical cause which philosophers have not taken into account, or even to recognize. From these cometic bodies we must infer that planetary space must be very much occupied with matter that is in some measure affected by the attractive energy, and that such matter progressively passes into vast compression as it approximates the sensible surfaces of the bodies to which it belongs. Were this not the case, there could be no escape for these cometic masses that have such an affinity for our system's center of gravity, for if they are constrained by solar attraction to come from far remote regions, we can not conceive what else could keep them from coalescing with the sun. To suppose that there is a physical force resident in that body sufficient to repel them when their distance is most reduced and the attractive power multiplied almost beyond measure, by the well-recognized rule of diminution by distance, would be the most consummate absurdity conceivable. That these masses should always escape the power of the planet's attraction, on their inward and outward passages, by making the entry and exit at a great angle from their plane of revolution, would be next to a miracle; but that they should escape impinging on the surface of the sun, or encircling him with much less eccentricity than they now do, would be an absolute impossibility, only for the reason of his far-extending invisible envelope that reflects them off.

A perpendicular descent could hardly be made upon a planet that was always rapidly changing its place, so it might be possible for the cometic masses to escape permanent attachments to them; but this would not hold good respecting the central or solar mass, which has no motion to prevent their actual contact; nor could the entangling effect of planetary force, by causing an oblique motion, always cause that angle of descent toward the sun to be such as that by which they are enabled to pass that body. Should the frequent visitation of comets, and their eccentric motions while passing through planetary space, and within the range of our vision, fail to convince us that their paths are through matter, and that this matter surrounds all the bodies more immediately belonging to our solar system, we have still further proofs of such conditions, very conclusively and intelligibly telegraphed by these cometic bodies to us by their *tails*, could we but understand the signs by which they are signified; for whatever may be insisted on, with respect to the laws of motion as understood by philosophers, they do not account for this phenomena. And whatever may be the constitutional quality of the bodies from which they are projected, the cause can not surely be in them; for they are known to gather this projected matter up as they recede from the regions that resolved its dispersion. Neither can these cometic projections be caused by any direct effort of solar action, for they are inverse to any such effect as could be caused by the attraction of that body. He is mighty for concentration, but impotent for dispersion, and the idea is to us altogether inconceivable how one body should attract another from remote distance by its power and then repel it away when it was the most immediately within its influence. It would be strange, indeed, for him to *repel* a mass that he had attracted from outer space, and at a moment when the attractive powers were augmented to their maximum intensity. Physical inquirers would do well to keep constantly in mind this very unquestionable fact, even under any hypothesis of power, for the attractive energy of any body must necessarily be by far the greatest resident power of that body, because, in virtue of that power, as is admitted, each body has at least its being. Hence any energy of a mass that could repel matter situated at a distance from itself, could much more readily dispel that matter in which it was itself resident; therefore the dissolution of every body would necessarily date from the very moment any repelling power was generated in them.

Therefore the power to project the matter of comets into these elongated tails can not possibly proceed from the sun as a repulsion, and, on the same principle, we may say, from no other visible substance; and, furthermore, we do confidently affirm (however paradoxical it may seem), that there are in nature no powers of repulsion, nor any *evidences* of such, except what are seen, and really the effects of the most concentrated attractions; for by the concentrating energy of that solar medium, in which comets are at times moving, a portion of their matter is projected outward by resistance proceeding from its central compression, caused by great central attraction.

Why cometic bodies should exist at all; what objects and ends they serve in the system of nature; from whence they come and whither they go; and by what powers they are impelled, are inquiries that are often advanced, but have never received any satisfactory solution.

We have demonstrated the measures by which other and more familinr masses were made, their final destinations determined, and their relationships regulated, and in a manner which we consider beyond cavil or controversy. We set out, in our physical researches, with the origin of all energetic matter in universal dispersion. We have proceeded with the measures and means of the great ingathering of all those quantities composing the central members of all the solar systems; we have deduced the manner and mode of arrangement by which they were formed and their places determined; and we have not yet found our way obscured by the mystifications that beset modern science in its researches, which mixes up matter in such a manner as will neither reflect nor transmit the physical ray, but only more and more mystifies and obscures the paths to be traveled.

But we will leave its devotees in their darkness, and pursue our way in the illumination of that solar beam of physical science which we have adopted as our pole-star by night and our beacon by day, and which will lead us on to all the truths as they have been revealed by nature herself.

By this we discover that during the universal harvest or great ingathering of matter into the central garners of solar association, much matter must have been left unappropriated—at least of that which was the most feebly affected; we have recognized the fact that matter most affected by this force would gather unto itself that which was next in the order of affinity, and these combined aggregations would be able to effect those of more feeble force, and so on, until all would be gathered into masses, save the gleanings of light and most ineffective matter left dispersed in the immensity of solar space. It would necessarily follow (in consequence of the infinitely modified force imposed upon primary atoms) that there would still be left in all space matter of such diversified power as would afford all the requisites for a reproduction or renewed harvest of forms, but certainly with far moro feeble energy than the first; and while there can be no doubt but this second harvest had its physical origin with the first, yet being far less energetically harvested, it has been, and still is, garnering up its forms into cometic concentrations. This light matter, left to itself in intermediate and immeasurable fields of space, would, in consequence of the unobstructed exercise of its own powers, feeble though they may be, cause a constant progression of spherical forms among this most etherealized matter, ever coalescing and extending their magnitudes and spheres of action till they would finally come within the force of solar affinity, which would make them pass over the intervening space toward the grand central attraction which rules the whole physical realm. Could we but witness these masses remote from the excitement of solar action or central obstruction, we should find that many of them would neither intercept nor reflect a solar beam, because there would be, under the favorable circumstance of their origin, no foreign influences to disturb the perfection of their fluidity in molecular forms, or the action of affinities causing their association in mass, that would impair their powers of transmitting the solar ray, more than our atmosphere now does. This would be the condition of the entire mass in many instances, while many more may have an opaque or partially opaque nucleus less pervious to light. The more solid and opaque the center, the more energetic must the matter be, and consequently it would gather together a larger bulk of this ethereal matter causing more compressive density to its own nucleus.

All those whose revolutions round our sun have been calculated, and whose return is frequent, can have but little magnitude, force, or effective consistency when compared with those that are altogether strangers, or occupy long and undefined periods in their passages into planetary space and back again. This first class are confined to calculable spaces which do not extend far beyond planetary circles, from which the concentrating masses of our solar system must have abstracted all matter except of the most feeble powers. While the second class, originating in, and retiring toward those remote regions that were longest relieved from the action of energetic bodies, has a more expansive and prolific field of action in which to exercise their concentrating energies in appropriating to themselves all outlying matter for which they have affinity, and by which they would increase their bulk, so that they return much enlarged beyond what they were when they last left planetary space. The great difference between comets and our sun, and the masses that encircle him in less eccentric orbits, consists simply in the circumstance that the sun, planets, and their attendants, are composed of much matter, to which this universal power (attraction) has more energetically attached itself, while comets possess but little matter of this description, and are altogether composed of that which is the most feebly affected.

The vast envelopes of ethereal matter that surround the nucleus of our planets (and which of itself almost composes the entire comets) contributes, as we shall hereafter see, to our physical perceptions of all sensible things (in many ways), still remaining in itself as unknown and unseen by our faculties as is the mind itself. It may be asked, why are not these envelopes of our planets as visible to us as is the matter of the comets, when they can not be of a less ponderable quality? We would answer, all matter assumes different forms and characteristics under different circumstances, and this being at liberty to exercise in full the affinity of its social relations, is, like the atmosphere, undiscernible. Our sense of sight does not inform us of the existence of that substance, yet we do not doubt the presence of the atmosphere, and that it exercises a pressure of sixteen pounds to the square inch; and we do not think it requires any remarkable degree of credulity to believe there may be matter with still far less energy than our atmosphere, and which would not come within the recognition of our senses, even if the pressure were not only sixteen pounds, but as many tons to the square inch.

No one can contemplate the great bulk of the comets without being convinced that their internal matter must be under vast compression, however comparatively light their constituent matter may be; for while they exercise a concentrating force that can hold so much matter together, and feel so strongly the gravitating effect of our system's central bodies, the pressure upon their own internal matter must be immense, notwithstanding their comparative imponderability, which imponderability is fully demonstrated by the near approach comets often make to other planets without producing the least sensible effect on them. We consider this to be positive evidence that all matter is *not alike* endowed with attractive energy; if it were, these comets would indeed be dangerous visitants, particularly on some of their nearest approaches. And because the condition of the matter composing the comets and planetary envelopes is not all within the sphere of our physical perceptions, this certainly does not negative the fact of their being composed of atoms of infinitely diversified energy, however minute or feeble the different grades may be, for it must comprehend all degrees of force, from metaphysical noneffectivity to sensible effectivity.

The idea that a repulsive power expands small portions or quantities of matter so as to produce great bodies like the comet, is an idea so absurd as to be altogether unworthy of being entertained for a moment. Bulk is, in all instances, to be regarded as a certain criterion of the quantity of physical matter contained in a mass, on the principle that one given space can contain neither more nor less matter than another given space of the same size. But the energy attaching to the matter must have an infinity of modifications, or substances could not be what they are; the quantity may be the same while the energy attaching thereto was very different.

Proceeding on the assumption of attractive gradation, as applied to primitive atoms, we have deduced the cometic formations to be the least energetic portions of matter last gathered up; and the reason why they seem less subordinate to solar influence than the planetary bodies, and why their conduct seems so unlike them in many respects, we find to be this: The energetic effects of a mass is not measurable by the amount of its matter, but by the activity of its attractive force. In the exercise of this attractive force comets approach near the sun, and are prevented from a perpendicular passage to, and an impingement upon, his body (as the attractive force of that mass would most assuredly determine) by his surrounding envelope. The deflecting effect of the planetary attractions would likewise be a preventive; while the planets themselves are protected from coalescing with the comets by their own envelopes, as well as by their rapid change of place in their orbitual revolutions.

When we consider that both comets and planets increase in density downward by the impact of their own matter in the ratio of its depth, we shall readily see how impossible it would be for bodies moving with such velocity to be either intercepted by, or penetrated far, with each other's matter. Were they under the effect of no other force than their own mutual attractions, their path would be in a perpendicular line, intersecting the center of each, and then their exterior envelope would be comparatively passive to the penetration of that which was more ponderable than itself. But not so with the acquired velocity of planets and comets passing at any thing short of right angles to each other, for in that case their motions would be so great as to reflect them off by the elasticity of their own compressions in the direct ratio of their speed; which will always be such as to render their coalescence a casualty not to be dreaded. So, from whatever quarter of the heavens a comet may approach the sun, it must be deflected from a perpendicular to that body by the attractive force of the planets, at least to the extent that the reflecting power of the sun's insensible envelope would in every case continue the obliquity of their motions so far as to allow of their passing round him. They, however, in their relative inclination to a perpendicular, would plunge more or less deeply into the sun's insensible mass, until the constantly accumulating force consequent from proximity and motion was balanced or repelled by the powers of the progressive compression of that medium in which the body moved.

The projectile powers of motion thus acquired by the descending body having experienced at this point of perihelion passage, the maximum of its resistance (from the sun's constantly increasing density of enveloping matter on approximation) would now begin to feel the effect of that force in an inverse order, that is, in place of resisting, its motion would have an accelerating effect, which would cause its recession by the same elongated curve as that by which it descended.

These deflections and obstructions which comets must of necessity encounter, when penetrating planetary space, must be the means of making their own paths, at each periodical recession from the sun, more or less divergent from each other, so that, unlike the planets, they will not make their repeated passages in precisely the same time, or in the same plane or path of the heavens. By this means they traverse vast regions hitherto by them unexplored, containing much matter, which they appropriate to themselves and enlarge as they go on and return. But when their paths are less elongated, and their periodical returns more frequent, these gleanings can not be an equivalent for what they lose in making their passages round the sun and in planetary space, therefore they become progressively exhausted in their periodical revolutions, as observation will abundantly testify; while those who go into the most remote regions, and seldom visit our system's members, will proportionally augment their mass. Many of these bodies, when farthest removed from our system's center, must be for a time almost stationary, and then the sun's attraction, which would effect their return (being at all times equal to itself), would act perpendicularly only for the effect of outward force, but more particularly planetary action, which necessarily curves their line of descent, to be deflected from a perpendicular to the sun, their maximum of bend being opposite the greatest deflecting force. And when their paths have been extended so far out into space, that their greatest deflections are far from being midway the length of their orbits, such orbits could not be an ellipsis, but such a figure as conic sections alone can describe.

These deflecting forces of the planets would not at all times be sufficient to prevent the comets from coalescence with the sun's visible surface, or to cause them to revolve round that body, particularly when they enter that system at high angles to the plane of planetary revolution. But, as before stated, the sun is farther protected from their coalescent descent and impingement upon the attractive powers resident in him, and which impels them onward even through the resisting effect of that medium which his attraction has made to concentrate round his solid mass, and to which these comets contribute much of their least affected matter while passing through its midst. But so long as these cometic bodies travel in space unobstructed by the energetic matter enveloping the sun or planets, their forms (because of the force of their own centers of gravity) must be perfectly spherical. But while thus traveling in space they will attract, and attract to themselves, by their own aggregate energy, any lightly affected matter that may have been left out in the general aggregation of the more energetic masses, and of this most feebly affected and diffuse matter their own magnitudes are the concentrative aggregates. These bodies, therefore (with occasional exceptions of their own compressively condensed molecules), when in such unembarrassed positions, and acting in the unrestricted freedom of their own molecular energy, must thereby be of a fluid and transparent character, and so altogether insensible to our faculties of perception, even though their matter immediately enveloped us; for all substances whose molecular constituents are so far from the effect of compressive restraint, that their associate affinities can fully act on each other, would so resolve their relative positions in the aggregate as not to intercept a single sunbeam, because of their susceptibility of luminous transmission. These cometic bodies, therefore, can only exhibit themselves to the full extent of their exterior sphericities when made to immerse themselves in the far-extending solar or planetary envelopes whose matter is of kindred character with that of themselves; in that case, the surface molecules of these moving bodies not assimilating in social and affinitive relation immediately with that of the matter in which they are immersed, they become for the time imperfect transmitters of the sun's rays, and so reflect part of them from their surface.

This very visibility of fluid bodies floating in space supposed to be free, is the best evidence we can have that their motions are among matter energetically and disturbingly effective; and the more remote from the solar body's sensible surface, or from the body of the planets, the more ineffective is the substance of their envelopes into which they may at times penetrate; for no matter can possibly remain in equally diffuse isolation in planetary space, while the attractive force of these solar and planetary bodies, as well as cometic aggregates, are so effective.

The deeper the cometic bodies plunge into these externally enveloping oceans of progressive condensation and compression the more visibly conspicuous they become, often to the elongation of much of their exterior matter into very far-extending tails. The progressive increase of the energy and compressive density of the matter through which the cometic body is passing, by gradually intercepting and suspending in itself that matter of the same energetic grade as itself, on the certain and simple principle that a lighter fluid substance will not descend into a heavier one, even though it has the attraction of the descending comet to drag it down, is the sure means by which the tails of comets are elongated when approaching the solar body.

However far from the solar center the comets may extend their tails, they can be visible or elongated only when within the sun's effective envelope, for otherwise their matter would retain its sphericity by virtue of its own common attraction; therefore the phenomena of their projections are by no means attributable to the forcible effect of any repelling power resident in the comets themselves, or in the sun from which they would seem to be reflected, seeing they are so usually found opposite to that body; for this would be a positive violation of nature's great gravitating law, by a force totally adverse and superior to the whole aggregate power of the attraction of both bodies, which we shall find for this and all things affinitively prevalent and formatively affective, and equally so for the lighter matter of comets, which, agreeable to the rule of this same gravitating law, constitute their exterior, which is made to extend outward, as forced from these bodies by their fall into this resisting medium among matter of its own gravitating grade, by which necessary effect of differently-conditioned fluid substances upon each other, this projecting matter of the comet's tail becomes most conclusive of the progressively densifying medium which must form the sun's usually invisible envelope. We then find that in perfect accordance with the laws of gravitating force it is that those cometic tails are projected in so great a measure opposite to the sun, whatever may be the rate of the comet's motion round that body; it being in the midst of this progressively densifying medium, while on its perihelion passage round the sun, and in the matter of much the same grade of energy as its own, would impart to it much of the most feeble cometic matter, and almost all of the motion in this sweeping circuit round that body, because of the repelling effect of the matter in which it was moving, and all that exterior to itself, which, having no lateral impediment in the same longitudinal plane, would circulate round with the comet, thus constantly retaining the tail in outward direction; in consequence of this rotatory motion imparted to the sun's envelope, any bending or inclination of the tails of these bodies is attributable to the more tardy motion of this solar medium, whose matter mixing with that frictionally escaping from the comet's body, because of its own rapid motion in this resisting medium, thereby becomes visible, this disturbed action of molecular affinity disqualifying for a time the nebulous matter for the perfectly free transmission of light. All molecular mixtures, while in the transition state, or while effecting an affinitive relation among themselves, have more or less of the nebulous aspect which characterizes comets and their tails, which then reflect instead of transmitting entire a portion of the sun's light operating on them, and by which we find the sun's usually invisible envelope manifesting itself to the senses.

We have an illustration of this changing aspect in the mixture of fluid substances in the meeting of the atmosphere and steam, for here the combination of the aqueous matter and the atmosphere do not affinitively assimilate at once, and thereby a reflecting cloud is formed, which affinitive action progressively, but surely and readily, transforms into a transmitting and transparent medium that no longer reflects light, because of its transmitting abilities having become perfect by the force of its own affinitive action. We may likewise often witness nebulous clouds in the atmosphere, both in their formations and their dissolutions, as well as other mixtures of aeriform or fluid matter, when the affinities are affecting the more perfect affiliations of the constituent forms, after their having been disturbed in their formative conditions.

Chapter Four.

Gravity, a discriminative property of Matter—Cause of Motion—Motion of the Planets—Cause of all activity on their surfaces—Coëxistence of Wisdom, Energy, and Matter—Secondary Conditions—Man's Superiority—Impossibility of the World's being spoken into form at once.

We have thus far followed the effect of gravitating energy as applied to the ultimate atoms. We have contemplated its effect in the sectional subdivisions of the whole material universe, in its eternal extension, into spheres of solar action; we have been witness of its effects in the aggregation of the suns, planets, satellites, rings, and comets which now are residents of this infinite severality of solar spaces. We have seen on what principles it constructed all their mechanisms and determined their relative positions. We see how it will continue to rule their revolutions and regulate all their relations; and if we have almost exclusively confined our observations to members of our own solar system, we have contemplated it as typical of the eternal series of material subdivision which universal matter must have experienced, with such modifications as might have been readily effected by the same force.

But in these observations on the effectivity of this force, in this much of its efficient exercise, we may not seem to have made more of it than would have been accomplished had gravity been an indiscriminate property of matter, with every atom having an affinity for every other atom, as physicists affirm; for in that case it could, with equal facility, have aggregated matter in massive solidity and imparted motion thereto, as it could have done by the discriminating rule for which we so strenuously contend.

There would only have resulted from these two modes of its application this difference: In the first case the matter of every substance would have soon determined its own collapse in total and eternal solidity, to the absolute extinction of all interstitial space, so that porosity of substances would have been an absolute impossibility, all material substances being nothing but solid aggregates circulating in absolute vacuity, or that condition which both physicists and our physical senses assume to be intermediate of material substances and void.

Now it is certainly very evident that it must have been very far otherwise with the discriminating application of this attractive power, the effects of which we have thus far contemplated; for, as we have seen, substances under its rule must have assumed such gradations of density as the forces of their constituent matter would finally determine, and which would not seem even to our senses as if they were perfect solids. But with all this we must at the same time admit that these very discriminating forces, as attaching to the infinitesimals, must have equally resolved matter into as perfect and perpetual a condition of rest as any indiscriminate application of the same energy and its solidifying of material substances could have done, for matter in either case, by the effect of its own attractive affinities of whatever grade, would speedily have been determined into the eternal quiescence of death; for no substance affected but by one species of force, particularly when that was of an attractive character, however graduated with this force its constituent matter may have been, could by any possibility have perpetuated activity among its own relative forms.

Planets may have revolved, and their relative positions may have been perpetuated, but as it is evident that all the matter of each must have participated alike in the general motion, so that relatively all would be at rest, for none of their matter could by this general motion of the whole have been disturbed from its relative quiescence, however lightly or loosely it may have held its attractive allegiance. Such would be the inevitable condition to which the attractive forces of any isolated body must have reduced its own matter, in whatever degree it may have been applied to its ultimate atoms.

This is certainly very far from indicating that life-like activity that we now find, by familiar observation, to be nature's everlastingly repeated expression. But what else, will philosophers say, can be expected from one such uniform force, with but one constant and uniform tendency, but this determination to eternal rest? This is to them so evidently and irredeemably the finality that such force would determine, that had there been no other rule of action than this one, which we assume to be the sole force by which nature effectuates her phenomena, they will hesitate not to decide that physical nature would have been an entire failure; for in place of a determination to an eternal quiescence, nature evidently required that there should be the energetic resolution of perpetuated activity.

The usual idea or axiom (as it is considered) of every atom of matter in the universe having an attractive affinity for every other atom conducting to such consequences as we have thus contemplated. and the idea of a discriminating application of this same force being considered of no more actively inducing conditions, philosophers find, and physicists fancy, that there necessarily is and must have been other active principles or forces effecting the phenomena of nature, or it would have been a nullity.

Agreeable to the existing notions, were there in reality no other force or law of motion than we assume, all the planetary systems would have speedily collapsed upon their own common centers of gravity, so that even their motions must have ceased. And were there no other law of matter than this, every substance would have become the most perfect solid in all the rigorous frigidity of eternal rest. To obviate the first dilemma, they (physicists) have originated the absurd idea, or axiom, as it is called, that motion is as much the condition of matter as rest. We say absurd, because matter could have had no two primary conditions, both of rest and motion, so diametrically opposed to each other; therefore the true condition of matter could only have been that from which it was first disturbed; and that being rest, it must have required an energy to have disturbed this rest, and which must necessarily have been the energy of motion; this motion or energy, when once imparted, being only effective from atom to atom in their aggregation, could not have imparted to such aggregates any free and independent motion in space, but would only continue effective upon them so far as their aggregating affinities or the affection of body for body remained unsatisfied; there is certainly nothing in this like what physicists call the first law of motion.

The inertial energy of any substance being first for its own constituent matter, and then for a coalescence with other substances, so far as the combination of forces effective from these other substances will admit, and this would be admitted to all substances were not matter in the severality of its conditions eternally continuous.

We are at a loss to find from what physicists deduce the inertial energy of matter which they recognize as motion's first law, and by which they assume that planets and all other moving bodies acquire and perpetuate their own forward and rotatory motions by means of their own inertial momentum, as primarily imparted by an initial impulsion, for there seems no way for this unless communicated by some unknown special and final effort of primary causation. Were this even fact, it could not be a philosophical fact, for it could be reached by no logical reasoning, the means physically in this case not being made *à priori* of the ends.

To obviate the second difficulty of the absolute solidity of substances, and their consequent frigidity in eternal death, they have originated the no less absurd doctrine of impulsatory and repulsatory forces and forms of action in all qualities, grades, and complexity of kinds, and in their conduct receptive and rejective together, or by turns, and thus effective of phenomena by a series of antagonisms in their fabrications and dissolutions, and multifarious conditions, characteristics, and kinds. Now, notwithstanding all the seeming necessity for forces and affections complex in character and fluctuating in their effectivity, we can not understand or conceive how complexity in power could determine unity of purpose, or how creative expression could be imparted by any series of antagonisms, or how such fluctuating forces could be at all times effective in just the requisite quantity, or how antagonistical forces could be as effective of any thing as the neutralization of each other's effects. Nor can we conceive of a scheme of nature conducted by contrarieties, or a source from whence such contradictions could have come. The great First Cause can not be a variability or contradiction in himself; and as independent, or out of him, there could have been neither force nor form in physics, the scheme of nature, therefore, could not have received its expression from any series of antagonistical forces or affinities, when such could have had really no existence. To his character in perpetuation and perfection he can have no attribute or active principle in adversion; opposed to his creative scheme of progression there can be in him no activities in retrogression; therefore if in him there are attractions, from him there can be no repulsions; the very idea of contrarieties or complexities, particularly in first principles, which must have had their source in unity, involves a palpable absurdity as being in violation of both his unity of character and integrity of purpose, which of all things are necessarily the very perfection of immutability. In a multiplicity of energetic forces effective of phenomenal expression, even if they would apply to matter, or be in accordance with the character of God, what can we conceive to be the nature of that effectivity which could control and regulate the extent to which they should exercise their individual or collective energies in creating the infinite and ever-changing phenomenal expressions of nature? for these contrarieties could not be expected of themselves to combine in the ever-changing degree which prolific nature requires for the forthcoming of her infinity of forms. We can not possibly see how they themselves could at all times have ordered the proper extent of their single or associate combinations of effectiveness, so as to modify the measures of their own or each other's activity in accordance with the multifarious phenomena of physical being. For this would certainly imply that the energies themselves exercised wisdom of purpose as well as powers of action; and this would be investing them with a faculty attributable only to that Intelligence whose unconscious instruments they could only be, were they effective at all. They could have no self-discriminating ability nor powers of mutation by which to graduate their action in giving effect to phenomenal expression.

However difficult it may be for physicists to conceive how a simple force, immutable in its mode of action, could have been the cause of all phenomenal expression in every phase of its ever-varying activity, it will be equally difficult to find any other force in physical nature qualified with that characteristic which is so essentially the attribute of every ultimate principle, for every other observed energy in nature is evidently characterized by a constant tendency to change; therefore these mutable conditions can only be entitled to the consideration of being of secondary and induced character. When confined to the simple gravitating force, it would seem that finite ability was baffled to find the relation between the phenomenal activities of nature as constantly transpiring and this simple medium of power; but nature has no such perplexities, for we find her in an infinity of life and motion, and no other sensible energy which could have been its cause; at least one of two things must be evident, either that this attractive force is not the only effective energy in nature, or that physicists have hitherto failed to find the mode by which she has made this force so unceasingly operative of phenomena.

While there remains a disposition to hold fast to the faith of a plurality of ultimate forces, adverse and fluctuating in their conduct and consequences, such will involve a sanction of the further absurdity of the great Original taxing himself with the constant superintendence of the conduct of such complex contrarieties; for it can not be expected that such blind conditions could properly manage their own doings, so that nature should go on in the even tenor of her way. Neither can we see how it should be expected that such complicated contrarieties could have been involved in the character of the great First Cause; for unity of character could not have constituted complexity in condition, and more particularly when unity of purpose could have been more effectually perfected by a unity of power, and that power, too, of such immutable integrity as could neither impede, abrogate, or annul its own initial or progressive efficiency. Gravity will be the only power found with all the requisite conditions and characteristics that can constitute a first principle of force.

In following the foot-prints of nature with strict regard to what are possibilities and impossibilities, we will still find this force forwarding us in our further researches, and as we have found the aggregation of worlds, their motions, relations, and relative positions to be but the phenomenal effectivities of this force, we no doubt will find it equally responsible for every other phenomenality of nature, notwithstanding there may be an infinity not yet accounted for, and most of them of such a character as would seem to preclude the possibility of their phenomenalities having been resolved by any such a lone rule of law. For how, it may be asked, can one simple principle of force, having but one tendency, and whose operations in that direction are as unchanging as physical nature's first cause, beget all the ever-changing complexities and activities of physics. This has never for one moment been considered as possible, for physicists could not but suppose that the effect of gravitating affinity, without any other affections of matter, would be the generation and perpetuation of an eternally frigid sterility, rather than the generator of all the changing activities of matter, for that it should induce the demolition of its own doings, and re-determine structural arrangements in all the infinity of their phenomenal phases, seems more than may be expected from any simple and unsupported principle of power. How, for instance, are all the modifications and expansions of the aeriform substances effected by the same force that forms the solidest and heaviest substantive masses? Or how is it to be conceived possible that this simple force, and that, too of an attractive character, should effect the formation of the most expansive and etherealized substance, and give effectivity to light, heat, electricity, and magnetism, in all the gradation of their diversifying characters and combinations?

All these are problems which are certainly yet to be solved, for we find nature has effected all these as well as every other phenomenal fact, by a method that no man has hitherto undertaken to define; at least in physical science, as it is at this time cultivated and inculcated, we see no evidence of it, and but very little that is satisfactory otherwise, more than in the phenomenal facts themselves and their practical applications; for when we seek, in the existing systems of philosophy for their dynamical relationships, we find all about as much of a mystery as ever, and about which speculation seems to have taxed its powers but to little purpose, all theoretical notions being only supported by inferences so far fetched or overstrained as to leave but little indication that they are the truthful expounders of nature's mysterious processes; but we find enough in these inferences and arguments by which to be satisfied, that if we do not deduce the nature of nature's phenomenal causations from this lone law of gravity, neither will physicists, with all their multiplicity of material energies or conditional kinds of materiality; for we see and are satisfied that with all the elemental forces or forms of ultimate matter that their ingenuity can bring to their aid, their systems are far from giving satisfaction even to themselves; but while these complications thus fail in solving the great physical problem, we at the same time find that but with one simple force nature has effected all her phenomena without reference to any other rule of action.

As we are now about discussing that department of physics in which the measures of nature are more particularly conducted in all the subtilties of nature, the better to understand not only the nature of these active subtilties themselves, but by what means there may be deduced from this simple and unassociated force every other phenomenality in nature, being that we hold its effect to have been the generation of every substance, every motion, every force, and, in fine, every phenomena there is or ever could have been, we hope it may not here be considered out of place, even at the expense of being tedious, somewhat to review the first effective measures of this ultimate power, with reference to its general efficiency upon matter as giving expression to creative thought; for if it could have been so effective, it is only by following its dictates that any hopes may be had of comprehending the expanding generalizations that constitute physical nature a universe of united severality. We have but to continue our observations on what must be the effective exercise of this attractive force, which we have found conducting us so safely and effectually in the measures thus far contemplated, and by which we have been passed in parallelism with nature, during the period and process of her most massive aggregating operations, in order to ascertain what its further relations and measures of effectiveness are with these massive conditions and motions already demonstratively deduced by its means, and we shall be able to perceive and solve the infinite multiplicity of nature's active phenomena as they evolve themselves under the multiplying measures of its effectivity. Therefore the principal *à priori* to the proper rule of research by which we may expect to obtain a proper understanding of nature's future and farther progress, is necessarily the recognition and observed application of the practical effects of this simple and immutable force by which all phenomena are really effected, and of whose action we have certainly seen sufficient to satisfy the most skeptical that by it the planetary bodies were aggregated, and their places and motions determined, and their positional relations perpetuated through all time.

Now this will, no doubt, seem as if we were deducing by far too much for the maintenance of this power's exclusive supremacy, by which we propose to revolutionize all existing theories and prove every principle in physical nature; for we have only so far deduced the circumstance to be self-demonstrative, that a simple, immutable, and unassociated force of this attractive character would have ultimately brought the constituent matter of every mass, together with every created thing, to a premature and frigid finality, in absolute and unconditional rest, and this, too, in spite of any discriminating mode of its application, without there had been, at the same time, something sufficiently effective in conservation of the infinite activities of physics. Now as force can only counteract the effect of force, and there being no force in nature but one, and that one having this positive and general tendency, it must itself be the very force continually acting in opposition to itself, in conservation of the continual activities of nature, and against its own determined efforts to bring matter together in rest, even paradoxical as such a proposition may seem.

Yet, withal, what is there so sublime as the very circumstance of a simple principle of effective energy, in itself immutable, being the only generator and propagator of all the infinite and eternal activities of nature, causing every complexity and change. Had this force and its effectivities not been eternally continuous, it could not have even thus conserved against its own determinations to motionless inactivity, but by this eternal extension it is continually operating against and defeating its own efforts in the reduction of things to such a motionless finality; and this must be the only cause of physical nature's infinite activity, for without a constant cause of motion, constant motion could not prevail; the idea of rest or motion being equally the condition of matter to the contrary notwithstanding. There was but one possible way in nature by which the perpetuity of motion could have been effected by the attractive force, and that was in its endeavor to reduce the planetary bodies to a concentrative coalescence with the solar body to which they are constantly falling, but as constantly flying away, thus causing their perpetual revolutions round that general and common center, and even this could not have been in long continuance, were not the action of this force universal, by which there being no general circumference to its action, there could have been no limits from whence all matter could converge. In every thing else, therefore, the mutual affinity of atom for atom would determine the extinction of all motion; we find that it does as surely resolve the eternal revolution of the planets, for their motions are the finality of the gravitating force as relatively affecting them. so that we find these bodies in perpetual motion as the resultant of the continual forces that are affecting them, in place of their being in that perpetual rest to which it is the continual effort of the gravitating force to reduce them.

These bodies being the only objects in the eternal catalogue of physics in which the gravitating power would produce a perpetuation in motion, in place of a permanency in rest, they are alone to be regarded as the sole source and origin of all activity; they are the great spur-wheels of motion, by which all the complicated machinery of nature is balanced, regulated, and perpetuated, as well as all minor actions, motions, and measures of complex activity among the miniature members attaching to these planetary surfaces. Who can fail to perceive the effect of infinite forethought in all this, the only measure in all nature that could have been made conservative of motion and activity against the force which rules the universe? Had it been possible for this force to have effected the collapse of planets upon their common centers of revolution, as most of matter had, judging from the magnitudes of solar masses, the total and universal extinction of all activity would have inevitably followed as its necessary effect, and nature, such as it would have been, could not have indicated the existence and wise forethought of a God.

Now, having proceeded this far in following up the effect of this gravitating force, as applied to ultimate atoms, and finding its energy to have been all-sufficient for solar and planetary aggregation and motion, and having fully demonstrated the fact, that there can not be a force in nature of which it is not the source, or a motion in matter that has not its origin in planetary revolution, yet physical inquirers will be at no less a loss than ever to comprehend how it can be possible to deduce all the activities of nature, either from this force, could it even have caused the revolution of the planets, or from these revolutions themselves, for it will no doubt be difficult to perceive what the orbitual motions of the planets can have to do in generating the active phenomena on their surfaces, seeing that the motions of these bodies is but the common motion of all their constituent matter respectively; every particular part of the whole partaking of this motion equally with every other portion, and therefore no more susceptible of relative motion among themselves than if the whole mass were at perfect rest, for all would be as lifeless on the surface of the moving body as if there were no common motion whatever.

Having thus contemplated the effective operation of this only ultimate force of nature to its consummation in the perpetuation of planetary revolution, and to where such a power would seem to have effected its finality in formative conditions, we find ourselves conducted to the only portal presented by nature through which the future conduct of that nature's relative cause can be revealed, and the only pass by which we can possibly procure entrance, being planetary revolution and its combination, which could not only have caused no perplexities in the creative process, but must have been one of nature's most efficient agencies in future and active development. But with all this it still requires to find how this pass is made practically applicable and free of entrance.

Now in this practical application there are formidable obstacles against which we will have to contend, not obstacles in the subject-matter itself, for that being nature's approved highway, can oppose no impediment; but these obstacles will consist in reconciling the facts of deduction with the negative or misconceived facts of observation while we are in process of exploring this phenomenal treasure-house of nature. We will have to combat many of the impressions that we have received through the medium of our physical senses, and as they are usually considered the best, if not the only means for the ingathering of physical ideas, we may not be readily successful in their removal, even if erroneous; and as we will find ourselves often engaged in the subjective discussion of objective conditions of which these senses have no recognition, we need not be over-sanguine in the expectation that such subtile truths of nature will be recognized with that ready evidence which characterizes the reception of the objects of sense; for many of them refer to conditions and forms of matter to which none of the organs of sense are practically inapplicable or adapted. Now, however novel or startling many of the propositions or facts of deduction found in this physical connection we are undertaking to trace may be, they are all readily deducible as phenomenal sequences in this great series of creative development, and necessarily following each other in the progressive order of creative expression.

Should this system of research or process of deductive inquiry which we are pursuing, conduct to the facts of phenomenal causation in all their relations, such will be a revelation of creative law for which physicists have long unsuccessfully sought, and which will cause no small revolution in philosophic thought, which must converge from vague speculation and concentrate upon the certain facts in the formulas of phenomenal resolution, by which alone the relation of cause and effect may be found, and every problem in physics solved. Most of the fundamental facts and propositions in this order of research we are pursuing, being so much opposed to the ideas derived through our senses, may make them, at first sight, seem hard to credit. Who, for instance (when it is proposed that matter is in an eternal unity), will be able to realize the idea that there is as much of it in the seemingly empty space through which he can the most conveniently pass as there is in the solid mass that the most effectually resists penetration? yet we have found this to be a fact susceptible of the most rigorous demonstration. Or who will be readily reasoned into the conviction (against all seeming reason) that the infinite phenomena around him, subject to endless mutation, are all effected by one and the same simple and immutable force belonging to ultimate atoms, or that they could produce such phenomenal complications, by any combination of their effectiveness? Or who will render ready credence to that force as effecting the most expansive explosions and the most determined condensations? Or who will readily realize the fact, that it is equally effective of the medium through whose means we are made the recipients of sunshine, as it is for the formation of the most solid metals, and with equal quantity of matter in each? Or who will readily recognize the process by which the revolution of the planets can resolve solar luminosity? Now however indifferently qualified our physical faculties may have made us for the recognition or investigation of these startling propositions, nevertheless they are either facts precedent of physics or necessarily following in the order of progressive development. Seeing that a simple energy in its several combinations could have effected the relative motions among the planetary bodies, and that to these motions among these bodies is referable all the infinite activity applicable to matter in perfect unity, and by which it is characterized in its life-like conduct, what shall we say of the wisdom that could have willed it so, and that with such paucity of means could have produced such an infinity of ends, and that could have caused this simple species of energy to be so efficient in its agency? All we know or can say of this wisdom is, that it must be infinite, and if we do not recognize an infinity of wisdom in this order of physical development, there are certainly boundless manifestations of it in the works of nature; and it certainly must be very evident that this faculty of the First Cause must have preceded physics, for the scheme of creation must have been *à priori* of its expression, however far in the retrospect we may have cause to consider its incipient impulsion. Before we enter upon the discussion of the subjects contained in what we may consider as the second section in our order of progressive development, we will again briefly review the character of the rules originative of physics, for with their character the inquirer can not be too familiar or well-informed; they being the elements of physics, must be the only elements by which the physical problem can be solved.

While we have observed the abundant manifestations of God's wisdom in his works, we must at the same time be equally sensible that without matter such a manifestation could not have been made, consequently wisdom and matter must have been associated in co-eternal fellowship; for although this wisdom was infinite and omnipresent, it alone could not have effected physical conditions or have generated an existence that was not already of itself, for such would have been a self-creation or an addition of something of which it was previously deficient. This would be the abstract principle of wisdom creating for itself a new attribute, as if the First Cause had been in himself inefficient for the creation of physics, and so first had to create or make up the measure of his own attributes before he could evolve physical existences, which we find he could not have done without matter; and for him to have created matter, he must have created it from himself, there being nothing else, and he omnipresent, which is absurd; for if it were in or with himself it would have required no creation, and it could not have been otherwise than with himself, or he would have been imperfect, and could not have repaired his own character. Surely to the characteristic attributes of this great First Cause no one will contend that there could have been any beginning, or that there can be any end or possible species of mutation. As we have already observed, the omnipresence of his character precludes the possibility of any ultimate elements of physical nature having had a separate existence out of, or apart from, him. Therefore what was in him must have been of him and with him, as an inseparable part of his being, in all retrospective eternity. Hence matter, as an ultimate and abstract element of physical existence, must have been everlastingly involved in this great First Cause, and not by any means a principle of after-thought and creation. And so, too, must have been the energy that was ultimately to be made effective upon this first principle of material omnipresence. The attributes of this great First Cause being thus omnipresent and eternal, precludes the possibility of their ever having been a point in the eternal expanse unoccupied by matter, or at which materality ends and vacuity begins. We may as well assume a total absence of God from portions of space, as to suppose that matter ceases to exist where our senses fail to perceive it, and which we are therefore induced to call vacuity, or that the eternal unity of matter is incomplete, even to the value of one simple atom This we will find in our further research to be a proposition so important, that if it is not considered fully demonstrated, it would have to be recognized as a necessary fact for the furtherance of physical development in this order of research; for without its admission the philosophy of physics can no longer be cultivated in this connection, nor with a scientific certainty in any other. As we have heretofore signified, this omnipresent principle of materiality, in its abstract character, could not have been but in the most infinitely passive condition, or it would not have been a willing instrument in the order of creative progression. Nor could it have been of kinds and qualities, for these would imply progress in the construction of such kinds. For kinds could only be recognizable by their special characteristics, which are necessarily secondary and induced properties, as the effect of progress, and consequently separable things, which this principle can by no means be considered, as abstracted from all force or affinitive action, being but the ultimate point of substantive entity, or the initial root of all physical numbers infinitely multiplied. This principle of materiality, associated with creative will in all retrospective eternity, so must have been the energy of that will as applicable to these ultimate atoms; and as to a simple point there could haye been but one simple attachment of force, but to this force there may have been many degrees of effectivity, but these could not have been characteristics in kind, for kinds could not have found an unassociated residence in a simple point, and any associated affinities must have been neutralent of each other's effects; besides, there could have been no origin to kinds, for the great First Cause can not be characterized by any specific severality of kind. These points of energetic attachment being in themselves indestructible, and creative will immutable, the energy attaching to these points which was to give expression to this will must have been immutably fixed, therefore there can be no possibility of subsequent change in these infinitesimal forces and materialities or their attachments, which are the root of all physics.

This ultimate order of principles, in themselves immutable and indestructible in unity, being incontrovertibly the only principles which could have given expression to physical nature's infinite severality, are deducible, independent of any doctrine of dynamical law, that is at this time taught or entertained by physicists; and as they would hope for success in their researches, they must give to it their unqualified assent, for by no force of logic will it be possible to controvert these fundamental principles of creative expression. This rigorous analysis to which it is thus possible to submit the creative attributes, can leave no question with respect to their intrinsic character, for we certainly find that no process of analytical reasoning or system of specific division could by any possibility determine a simple atom of an immutable character from its simple state into a series of specific kinds of elementary matter, such as physicists have now found to number over sixty. We see that it is, at the same time, equally demonstrable that the forces effecting matter can not possibly have a foundation in specific severality, for specific kinds of materiality or force must be by distinctive characteristics, which necessarily involve compound relations that can not be of an ultimate character. Nature beautifully and harmoniously has superseded the necessity of all this complication of kinds and qualities in matter and force, in giving expression to creative thought by imparting to the unity of matter a unity of power, in such series of gradation as would insure all the requisitions involved in the great and eternal scheme of creation. This scheme and this application of power having the same source, must partake in all the relative perfection of this infinite forethought. Force, however simple and inseparable in kinds, being in itself a property susceptible of infinite gradation and an attribute of infinite will, application could have readily been apportioned at pleasure. And notwithstanding matter in the abstract may have been inseparable from the eternal duration of the great First Cause, that cause being universally involved in the perfection of his own omniscience, without operating in physical effectivity, would not from necessity have germinated the existing order of nature but in accordance with his own good will and pleasure. Matter, power, space, and time being inseparable from him, he could have become physically effective at will. Why he should have deferred the exercise of this will, or how far in the eternal vista of the past since that will first became effective for physics, we have no data from which to determine, nor is it necessary for our purposes that we should know. Neither could our faculties comprehend its retrospective extension, even could it be enumerated in any number of appreciable cycles. But though we have no data from which to calculate the period in the eternal vista of time when physical nature made its first move, we have in all things abundant evidence to satisfy us that its practical application was not in retrospective perpetuity, for there is not a phenomenal fact in nature, nor has there ever been, or will there ever be, that is not of a secondary or derivable character, having their origin in conditions precedent; therefore none of these conditions could, by any possibility, have had a retrospective eternity, as there must have been a time before such secondary conditions could have had their beginning. The ultimate principles of physics must have preceded every physical condition, for nothing but the elements of things could have orignated things, and an origin of things implies a beginning to things, and a time anterior to or at such beginning. The origin of all phenomena must have been as much preceded by the roots of all phenomena, as wisdom must have preceded all systematic order of works. But ultimate principles, whether of wisdom or of power, or of a passive object in the character of matter to which it could have been applied, do not necessarily imply that these principles were in perpetual activity in the retrospect. But the immutability of the Wisdom that willed this application of affinitive force must be an unfailing guarantee or perfect pledge of its perpetuation in the prospective, for a power appointed by such a principle could never operate its own modification or extinguishment, nor could it be again received back into the same origin from whence it came; hence the forces affecting matter must continue everlastingly effective for physics in their progression.

From this inability of force to be effective in any general process of retrogression among the phenomena of physical nature, we may infer the absurdity of the theoretical notions of the nebulists, who suppose that suns and systems are but of temporary association or solidity, being of every-day growth and decay, and that they aggregate their matter during certain periods from surrounding space, and arrive at maturity by processes that have no powers of perpetuation, but that they again dissolve into the diffuse matter from which they originated, and that their durations, when compared with the time this alternating process has been in progress, are only to be considered as transient existences that run their separate and respective races, until they, by explosions or conflagrations, resolve themselves into space in wide-spread dispersion, by the concentration and reconstruction of which nebulous and far-extending matter it is assumed that new suns and systems are again formed, and in constant process of formation and dissolution.

Contemplating the immutable character of the Creator, we must regard the application of power to the only principle to which it could attach physically as being in perpetuity, therefore this must altogether preclude the possibility of any such existence as a wide-spread nebulosity in nature, or any such a rending or dispersion of solar or planetary matter as we see often assumed, or any such a retrogression in physical order as these supposed dissolutions and reconstructions would imply.

When physical speculators and nebular theorists become better informed on the subject of physical law, they will find that in interstellar space material substances of energetic tendency could have no such diffuse expansions as those usually mistaken for outspread nebulosities, and that the mutations of suns and systems is altogether incompatible with the character of Him who caused their formations and constituted their relations. Omnipotent for their forthcoming, it is not in character with the immutability of that Being to retrace his own steps by such retrogressions as setting back the order of progression so far as resolving these substances into nebulosities, in order that they may again condense and go through the same progressive round of development as at first.

Being able to deduce from phenomena and the known character of God, that the practical application of his power must have been in perpetuity, and that simply by an attachment systematic and discriminating of his own energetic attribute to the passive and abstract atoms of his own material essence, we have found that that very instant universal nature must necessarily have begun its physical activity, though certainly very far from that condition of nature or activity that now obtains, and which our senses enable us to appreciate. Physics must have run through an infinity of phases before reaching this remove from its most early inception.

There it was qualified as a primary attribute of the Creator, *here* conditioned in accordance with the organic functions of the creature, and intermediate of the two a measureless expanse to be spanned. Between the Creator and the creature matter in some of its measures of formation must be found, all being in connection with all, in one grand and progressive series of unitile severality. The wisdom of infinite thought, and the infinite expression of that thought being one and the same with nature and nature's God, all is resolvable into one and one into all. With this incontrovertible fact constantly before him, who will conceive for a moment that man's physical powers of penetration bound the sphere of physical being? What probability can there be for him to reach the root of physical nature by analytical induction? In this inverted order of research, no means at his command, either natural or artificial, can carry him far below the surface of things visible to sense, beyond which and the origin of things the physical connection must necessarily be complete. Man's powers of sense, together with the artificial aids he can supply, serve him well for his safety and sustenance, because for this they were bestowed upon him in common with other creatures. His superiority over them consists in there attaching to him a greater reflux effect of that reasoning power which renders creation; for, by a proper cultivation and application of this power, he is privileged to hold intercourse with the Originator of that creation in giving expression to his plan, and from which alone he can deduce both the *direction* in which his powers will be most effectually applicable, and the manner in which he may the most successfully canvass the causes that have ruled this creation to be what it is.

Acting on this principle, and not by the restricted rule of inductive research, we deduce from the first principles of things what primordial matter must have been, and that it was essential to the stability of nature, and certain from the character of God, that this abstract materiality should be indestructible; and we find it equally essential, for the same reason and from the same character, that the energy attaching thereto shall never be abrogated. Without these proper provisions, there would be neither certainty for nature nor safe calculations to be made on physical conduct; for the instant this energy was withdrawn, or should cease its action, that same instant matter would be to us as though it had never existed, as it could in that case have no physical effect whatever, and our consciousness of it altogether depends on the effective expression of this force. The forces of physics being the effectivities of physics, in the total absence of physical energy matter would be a physical nonentity, notwithstanding all its seeming indestructible solidity.

Now that we have but these essentials for physics that can be so incontrovertibly established, and seen it demonstrated that there could have been no other, they may seem but a very insufficient base on which to build the superstructure of the universe, or effect all the active phenomena of nature; and to some it may seem circumscribing within too narrow limits the future effectivity or immediate instrumentality of the Almighty Originator, to suppose that the physical structure did not require his constant efforts, as practically perfecting by immediate volition of his Almighty will all the phenomenal passages in physical progression; for this is the idea with which mankind are usually most pleased.

But how much more grand and God-like is the scheme of the eternal superstructure of physics, and the equal security and certainty of its ultimate development, by the means and measures of ultimate principles appointed for its production by the creative ability of infinite forethought, than would be any scheme in which this power should require to be the practical operator or artificer of all nature's multiplied phenomena, in all their minutiæ of detail and adaptation to the general whole! Or his self-appointment in the capacity of overseer or general superintendent, with the self-imposed task of constant vigilance directing and urging his operative and adverse forces to special acts and prescribed duties! Surely we may say of the great First Cause, that to execute was but to will, for all the operative energies being in and of him, and he comprehending an eternity of both time and space, he had but to will the extent to which they should operate upon each other in physical formation; for in this connection this will would embrace all extension, for he could not really will that which would not be. But by no volition could he have made them immediately effective of physical forms as they now exist, or previous conditions could not have been; space and time being associate, though negative qualities of this same great First Cause, physics must necessarily have been a process progressive, or time in its term would not have been satisfied. God could not have willed the worlds into immediate existence, for that would have been to pass phenomena through an infinity of secondary conditions, to which no primary order of principles could have been made thus instantly to apply, further than that induced by the affections first imparted. All secondary conditions being thereby subject to mutation, no immutable principle could have been by any possibility made to apply to them in thus pushing them instantly forward. Primary principles are altogether unsusceptible of sudden impulsions in phenomenal expression, or modified intermissions of activity, therefore they could only have been effective progressively and uniformly, in the consummation of phenomena, past, present, or prospective.

Admitting it to be fully demonstrated, that the attractive energy is the only force affecting matter, and that it could not have otherwise attached, than to the atomic infinitesimals, we have in this a nucleus for the safe generalization of all physics, a sure starting-point, for which the philosophic world have long seen the necessity, but for which they have hitherto searched in vain; and now that this root from which systems were erected, and from whose depths their progress can be contemplated, is thus presented in all its unpretending simplicity, we apprehend that it will be received but with tardy favor, because of its seeming insignificance; this apprehension must be our excuse for keeping it so constantly in view, even to the tediousness of much repetition. We trust, however, that with the contemplative observer, the very simplicity of this fundamental and all-sufficient rule of physical action will be no inconsiderable recommendation in its favor.

Chapter Five.

Section Second—Reason for this Division—Attraction of Atom for Atom—Planetary Motion the Cause of Light—Construction of Aggregates—Molecular Matter—Elevation of its Pencils—Reciprocity of Elastic Action—Transmission of Light—Spots on the Sun—Character of Luminous Pulsations—Undulous Action.

The reason we consider physical research divisible at this stage of phenomenal progression is, that up to this period we have been able to follow the operations of nature by a certain system of causation, to where they would seem to have effected a finality in mass and motion, and even with this single force or lone law of nature (philosophers say), this motion of planets would have been precluded by their convergent coalescences in one central mass; and admitting the proposition as fully proved, that these could, by this force, have been perpetuated in their motions round a common center, what could this mass or motion, even in changeless perpetuity, have done in affecting the infinite and ever-changing activity of nature? No moving mass, whatever its velocity or magnitude, could have disturbed the quiescence of a single particle of its own matter; then how could we expect them to affect each other, separated as they are by millions of miles of intervening space? Except the motions of the planets, as we have seen, this attraction of atom for atom would not fail to reduce all things in nature to a state of absolute rest, causing the total extinction of all activity consequent from the affinitive aggregation of matter in mass, permanently placed as the finality of this force. Finding that the conservation of any species of activity could only consist in the effectivity of this force continually defeating its own endeavors to cause the coalescent convergence of these planetary bodies, this being the only instance in nature wherein this constant tendency of force can consummate such an event; that is, because the aggregate force common to the matter of these bodies, individually and relatively, is constantly deflecting them from that solar center of this power to which the aggregate of their affinities is as constantly forcing them, this, therefore, being the only perpetual motion, or power to perpetuate motion, to what else can we attribute the everlasting life-like activity of nature? for the attraction of gravitation being the source and sole cause of action (even though its sole tendency is to reduce matter to rest), every effect is necessarily referable to this as the only force to effect the activities of nature. Now this continually efficacious conduct of the planets, in keeping all nature as well as themselves in constant motion, is certainly very far from what is usually expected or what is considered to be common experience. For why (it may be asked) seek for the cause of action in the planets, when all experience proves that the source of all activity is the sun, he being the origin of light and heat, life and motion? This may be a convenient idea, but it is neither a philosophic or a satisfactory way of disposing of this great problem; for, so far as we have followed the footprints of nature, we have found the solar body no more entitled to the consideration of being the perpetuator of his own activity, or that of any portion of his own matter, or of the activity of others, than is any other material substance whatever, all being alike; there are no separate rules for him and them, matter and force being the same in character in all bodies. How could the sun become qualified to perpetuate action or make his own matter effective *per se?* The matter of the sun is no more energetic or self-exciting than the matter of the planets, only in the aggregate and excess of power of that body over that of others; and this, instead of generating action, is only the more energetic in the quiescence of his matter or motal effect. Therefore this superiority of magnitude and aggregate energy would be far from conferring upon that body this special qualification, the matter of his mass being in itself nothing more than that of other aggregates, as effected by the affinity of their own mass. There could be nothing to excite activity and its perpetuation in that body more than in any other massive body, and his magnitude would more particularly militate against motion than would those of less dimensions.

If the fact is not self-evident, we have certainly fully demonstrated that the attractive force would speedily effect among the matter of any mass a finality in absolute rest, and there is no possibility by which the solar body can be an exception to this rule, so that his matter could in itself keep up luminous excitement. If, therefore, there is nothing directly in the matter of the sun or planets that could in itself beget or perpetuate luminous action in their own mass (or any other), the circumstance that such action is perpetuated proves the exciting cause to be something that is not, nor ever can be, at rest; and that something is only to be found in the planets, theirs being the only perpetual motion, or ceaseless activity there is in the universe, all other action must have its origin in that. Still it will not be evident how it is that this planetary motion excites luminosity in the solar body, or leads to the infinity of phases which phenomena assume on solar or planetary surfaces, causing all the activities of nature.

The question still remains unanswered, How can the sun and planets be thus reciprocally effective of action on each other's surfaces, they being separated by myriads of miles? Even were it admitted that the attractive affinity was what we say, the sole physical force, and that its universality and unity kept planetary systems from collapsing upon their common center, still it may be difficult to perceive by what process planetary motion can make the sun to shine, or how generate the numberless, fluctuating, and active phenomena of present conditions, which would seem to have so little to do with the motions of the planets.

This is the grandest and most important problem in nature; one whose solution has never heretofore been effected or attempted by any intelligence inferior to that which devised and carried out the infinite conception, whose scheme and its consummation in creative expression have remained undiscovered until now, that is, the means and process by which it was effected. And if any thing is calculated to make us feel the sublimity of that Being's creative conception, it is the wisdom and simplicity of his measures, and the contemplation of the manner he thus carries forward physical nature in active perpetuity, by the very means that man has or would decide upon to cause eternal quiescence in all the rigor of aggregated massiveness.

Proceeding on the assumption that there is no force in physical nature other than attractive affinity as first attaching to ultimate atoms in graduated degree, the solution of this great problem will necessarily be made to depend on conditions as thereby determined, for if not deducible from this source of power, it can not be entitled to the consideration of being the sole fabricator of physical phenomena, and the scheme of physics we undertake to prove by its means can no more be the true scheme of nature than other of the speculative theories it purposes to supersede.

But, on the other hand, if it be found still effective in transporting us across this seemingly impassable gulf, and forwards us as effectually and familiarly to the cause of all future phenomena in nature as it has to that already contemplated, up to this point it will certainly be entitled to the full credit of all we claim for it.

On the application of this energy to the atoms of matter (in this graduated degree) we have found its first effect was the resolution of all such atoms into spherical forms with the more energetic atoms for centers or nucleus points, and the lightest for circumferences. The primary atoms being thus affected with energy in gradation, so would the ultimate molecules form in like graduated degree, depending upon the force of the atoms forming their respective sphericities; these, again, would associate themselves in the further construction of other spherical forms of molecules and sub-molecules in compound character, still continuing to be progressively less dense from their center outward. This process, by constant repetition and molecular multiplication, has produced sphericals of every grade, from the first-formed molecule to suns and secondary bodies of the greatest magnitudes.

All aggregates, from the most minute to the most magnificent, are spherical bodies from necessity, constructed on precisely the same principles as the first forms, only the greater magnitudes necessarily cause greater pressure upon their common centers of gravity, and greater pressure causes greater solidity, and solidity is not always favorable to sphericity of form.

The most feebly affected molecular forms must necessarily constitute the most exterior molecular stratums of all aggregated masses, for they would be expelled by the more energetic matter seeking its way to the center. By this means the external stratums of molecular or massive aggregates would be of those forces having the feeblest energy; but these forms being under no compression from incumbent matter, they would, by the force of their own constituent affinities, be able to retain their perfectly spherical formations. Thus the surface of the envelopes encircling suns and secondary bodies, would be spherical in the aggregate of their infinite series of molecular sphericities, and they would be very far removed from any disturbances affecting the visible surfaces of these bodies.

These extensive oceans of insensible molecular sphericities will necessarily be found progressively densifying downward to the visible surfaces of such bodies, where the aggregate pressure causes the most energetic nucleus matter of such sphericities to assume solidity, because of the constantly increasing pressure; it will likewise be perceived that in these vast and visible bodies, or in the substances of their invisible envelopes, there could be no possibility of unaffected or metaphysical matter intruding itself, as affinitive matter would determine its entire expulsion, because of its infinite passivity; so that there would be no mixing up of abstract or metaphysical atoms of unaffected matter with the molecular forms affected by affinitive force.

Now this totally unaffected matter (although altogether disqualified for, and excluded from, any participation in such structural formation) we shall find to be one of the most efficient mediums in nature for operating the perpetual activity of physical existence, and this effectivity is the consequent result of its own passiveness, paradoxical as that may seem.

Thus finding energetic matter, of whatever grade or degree of force, all necessarily resolving itself into an infinity of spherical forms, and these again reconstructing themselves into spherical substances of constantly increasing magnitudes, until suns and secondary bodies are evolved with their sensible and insensible quantities, it must be evident that the most feebly affected molecules would be ruled to their respective places in the most extended circumferences of these bodies, because of their progressive density downward, which places being the farthest removed from, and on the utmost confines of, molecular affinity, must necessarily be in profound tranquillity, unaffected but by their own formative affections, and their tendency to one common center.

But feeble as these molecular forms may be, they would be sufficient to exclude all unaffected matter, because of their own aggregate energy on one side, and want of it on the other; these external forms being thus uncompressed and spherical, will cause the convex surfaces of the surrounding mediums of suns and planets to consist of an infinity of molecular hemispheres constituting the conjunctive plane, where physical matter ends and metaphysical matter begins; the subtilety of these confines makes no less sure this effect of formative force. These conditions of matter, though beyond the reach of our physical perceptions, are nevertheless deducible conditions, which can be as well defined as any affecting the senses most forcibly. And these extreme sphericals, now about to figure so importantly, are as much to be calculated on in their measures of magnitude and forms of force, as if subject to sensible inspection. They, as spheres, however small, may certainly be regarded as substances of no inconsiderable magnitude, when compared with their atomic constituents. The very circumstance of being spherical substances is in itself significant of the much more minute character of their ultimate constituents than of their own forms. Therefore the abstract atoms forming that measureless ocean of intermediate, unaffected, abstract, passive, inert, and unresisting matter, occupying all interstellar space, intermediate of aggregated substances, and in contiguity with the outer surfaces of the far-extending envelopes of solar and planetary bodies, being of equal character with the abstract infinitesimals or atoms of all structural formations, could not, at its junction with physical matter, repose on a parallel base, but on an extended series of molecular semi-diameters or hemispheres, forming the extreme surfaces of solar and planetary substances.

We shall now see how this peculiarity of junction between the matter *affected* and that *unaffected* can be the cause of that blissful order of activity by which all nature becomes redolent of light, life, and loveliness; but we must see, at the same time, the necessity of strictly observing correlative conditions, as heretofore deduced, and likewise the necessity of being fully impressed with a sense of their true character; and one very important condition in this connection is a proper appreciation of the infinitely inert and passive quality of all that matter occupying interstellar space, and intermediate of the molecular surfaces of the extended envelopes of suns and planets. We must fully realize the existence of an infinity of matter in its abstract and purely metaphysical condition, and as unresisting and obedient to the influence of energy as though it had no existence whatever, but at the same time so full, complete, and eternally continuous as not to leave an atomic point unoccupied by an atomic resident in all interstellar extension.

These atomic individualities constituting this eternal sea of intermediate matter, being thus in contiguity with each other, and with the sphericals forming the exterior surfaces of the sun's and planet's outward envelope, and being themselves utterly impenetrable by each each other, and entirely unable to penetrate molecular forms, because of the force of their formative affinities, this being their position and condition, any elevation of any atom resting on the hemispherical surface of an exterior molecule, that being the base of a whole column or pencil of such atoms, would necessarily cause the instant elevation of that whole column to where it would be projected against the molecular surface of some far distant and opposing body perpendicular to itself. And as it would be with one atom and its continued column, so would it be with all having the hemispherical surface of forms affected by the energetic action of their own matter for their extended base. Now this is precisely what takes place with the matter intermediate between the planets and the sun, or other far-distant bodies in the excitation of light; for a planet in its motion round the sun is continually passing among this metaphysical matter, which has no force to oppose molecular affinity or motion, therefore can not by any means penetrate the superficial molecules of the planet's insensible and far-extending envelope, however lightly effective their formative affinities may be; it must consequently pass over the circularities of their hemispherical semi-diameters, by which they alternately elevate and let fall the pencils of this metaphysical matter in contiguity with themselves; they being the base of their own continuous succession of columns, these columns or atomic pencils must participate in such elevations and depressions as the molecular hemispheres of their base would occasion even in their whole height, to where they could be returned by some other elastic substance, in far-off space as that by which they were excited, be that ever so remote. Now, as the matter constituting these columns or pencils is perfectly passive and metaphysical in its character, it may not be readily seen how they could effect any agitation in molecules formed by energetic affinity. This we shall find to be but another instance of the wonderful adaptation of all things to all things in the eternal unity of nature; and that, too, by means that would seem totally subversive of, or at least inadequate to, such ends. Paradoxical as it may seem, we shall find that this ocean of metaphysical and intermediate matter (though so perfectly passive, as in itself not in the least to oppose the passage of the planet, and equally altogether unqualified for effecting or abrogating the slightest effort of energetic matter), is nevertheless the medium of imparting to that very matter the most intense activity, and may be said in reality to be the source of all the life and light of the eternal universe, being the only intermediate materiality there is between remote bodies, by which all can have a connection with all. We have remarked that the columns or pencils of these atoms, however elongated they might be between body and body, would be wholly elevated and let fall over the circularities of the outer hemispheres of the surface sphericals of planets in their passage through this inert matter. But as there can be no vacuity in nature, not even to the extent of an atom, and these atoms impenetrable, it remains to be seen how these pencils could have room for elevation or oscillation; and if elevated over the semi-diameters of the surface sphericals, why they should again so instantly fall back into the depressions, for as they have neither ponderosity or elasticity, they could not do so of themselves; therefore they of necessity must be returned by some substance having a similar elastic affinity of action with the formative surfaces by which they are elevated.

This essential order of condition susceptible of luminous activity is admirably supplied by the enveloping mediums of the suns and planets all being of a similar character in their constitution,or elasticity and compressive tension, and we will find the oscillatory activity of the atomic pencils of light to be induced therein as a consequence of the attractive force continually urging the planets forward with great velocity in their annual revolutions round the sun, for such makes them pass through this passive ocean of metaphysical or unaffected matter that occupies planetary space, and is the only material medium by which remote bodies are connected with each other.

The surface sphericals of the sun's envelope, and likewise that of the planets, with which this passive and metaphysical matter is constantly in contiguity, being formed by the affinity of their own constituents, could not be affected by this infinitely inert matter passing over the circularity of their exterior hemispheres, for perfect passivity could oppose no obstacle to positive energy however feeble; therefore were there vacuity into which the atomic pencils could be elevated, however distant such vacuity might be, these spherical surfaces would thereto elevate the pencils, without any impression being made on themselves; but as there are no vacuities, these pencils of metaphysical matter, as they are elevated over the molecular circularities of the planet's most extended surfaces, they must be elevated against other substances of effectively elastic matter, however remotely situated such substances may be; but as those pencils that are more particularly perpendicular from our planets to the sun are now the more immediate object of our regard, we perceive that they at least have not the vacuity into which they could be elevated; for each extremity of these atomic pencils, intermediate of these bodies, is resting on, or rather in contiguity with, their energetically affected forms, so that these pencils could not pass over the molecular hemispheres of these rapidly moving planet's most exterior matter without being instantly projected against the opposing body's most exterior molecular elasticity, on which they would make excitable impression because of the elastic susceptibility of both surfaces; thus the elasticity of the sun's exterior would be made to reciprocate the generated excitement caused by the passage of pencils of metaphysical matter over the external molecular circularities of the planetary body's most extended surfaces in their rapid motions round the sun. The molecular formations on the exterior surface of the sun's enveloping medium being of the same elastic character with that of the planets, would resist this elevation of the atomic pencils of metaphysical matter over these molecular hemispheres of the planet's exterior matter, as much as these hemispheres would enforce it, consequently the rapid motion of the planets would cause a constant and equal derangement and restitution of the effective elasticity of these sphericals on both surfaces of contiguity with this metaphysical materiality which occupies all intermediate space, so that by this metaphysical matter it is that the sun and planets are made physically and infinitely ready to reciprocate excited action, however induced. This reciprocity of excited action on the surface of such bodies, induced by the constant derangement of the affinitive elasticity or hemispherical sphericity of these exterior forms, would cause the atomic or light-begetting pencils to oscillate incessantly between these bodies as they passed over the molecular hemispheres of the exterior envelopes of planetary masses.

Now it will be perceived that these atomic or light-begetting pencils will take no longer time in their oscillations between the outer surfaces of the planets and the sun than they do in passing over the hemispherical convexities of the earth's most exterior forms; which, when we calculate the vast velocity of the moving body, we may consider as instantaneous, and so will it be, let the distance between bodies be ninety-five millions of miles, or ninety-five million of millions, while nothing intervenes but this metaphysical matter, for it has nothing to oppose its instant motion, and nothing can not be made something by any amount of distance, that is, if there was not the least force of opposition in a short distance, there could not be the least force of opposition in an infinitely extended distance; therefore time can be no measure of luminous transmission between body and body, as it is usually calculated to be, the infinity of luminous exciting pulsations being instantly at both ends in whatever infinity of extension, or they could not be produced at all.

This metaphysical medium of materiality being the only possible link by which physical body can be connected with physical body, when so remote from each other as the heavenly bodies usually are, must necessarily be the only means or medium of activity by which that connection can possibly be made effective; and this oscillatory mode of action is the only species of activity of which it can by any possibility be susceptible, for with this ocean of intermediate metaphysical matter, the effectivities of physical matter can have nothing more to do; for while all else is clearly and uncontrovertibly aggregated into substances, with terminable surfaces, by the simple exercise of its own effectivity, and bodies made to circulate by the effect of their own and each other's affinity, this matter never having been energetically affected, must remain infinitely passive to all energetic action.

Now that we have deduced the only material and effective connection there can be between body and body, so infinitely remote from each other as these heavenly bodies usually are, we must still further pursue the effects of this passive and metaphysical intermedium to find why all the bodies are not luminous alike, being that we have found them alike in their matter, energy, and constitutional economy, or why there is any of them luminous at all, or what it is that determines this preference in favor of solar bodies, all being induced by the same active energy, and all connected by the same passive matter, capable of imparting nothing but the perfect reciprocity or oscillating interchange of excitements induced on the surface of enveloping mediums, by the planet's passages through this metaphysical matter; and this perfect reciprocity, as it will be perceived, relates only to the action of the surface molecules of the several bodies, neither of which are directly luminous under this action.

The susceptibility of bodies for such excitability as becomes luminous, is made to depend on the condition and compressive density of their enveloping mediums; and as we find the sun to be the only member of our solar association whose exterior medium is so conditioned, we must observe, therefore, the effect of this transmitted excitement upon the susceptible medium by which he is surrounded, so as to ascertain by what process it is that this excitement becomes luminously intense; for we must know, that on the extreme verge of the sun's envelope, where this excitement from the planets is first received, is where the physical and the metaphysical meet; therefore physicality can not there be so conditioned as to have any direct or sensible effect upon phenomenalities situated in the understratums of the same medium, for there the affinities of matter are the most feeble of all, and we must likewise be aware that this enveloping medium being so vastly deep and progressively densifying downward, that it would take the pulsations caused by these transmitting pencils considerable time to operate their way downward in this densifying substance.

The surface envelope of the sun's body as first receiving excitation from the planets by medium of atomic pencils, we demonstratively find to be very far from his luminous disk, as made visible to us; and were that really the most extended circumference of his effective matter, he would have nothing more to make him luminous than the planets, and not only so, but in such a case there could be no luminosity at all; for it requires that the enveloping medium or luminiferous ether of solar bodies may be differently conditioned so as to cause their susceptibility of effecting the condensation of received excitation, so that it may become luminous.

Let us now consider the effect of these oscillating impulsions as first imparted to atomic pencils by these passing over the molecular hemispheres of planetary bodies, and as received upon the circumference of the sun's far-extending and densely compressed but invisible envelope. We find by the elasticity of this medium, that it would be highly susceptible of propagating their infinite repetition inward and downward through its vast depth; but as that progressively densifies and converges downward to his visible disk, the received oscillating pulsations could not be the same in any two parallels of this excitable medium, because of the convergence of this excitation from the far-extending surface on which it was received, and its penetrating into a substance densifying by its progressively increasing compression.

We must be readily aware that these light-generating impulsions would be far from being instantly transmissible from the surface of this solar medium to that body's visible disk, as we have found them to be from body to body, by the metaphysical and passive matter which there intervenes, because in the sun's envelope they would have to make their way in opposition to the affinitive action of that fluid, and the compression to which it was subject, for such an excitement could only be by the disturbance of the whole constitutional elasticity of this progressively intensifying medium through which it was passing. These pencils would necessarily oscillate at intervals progressively more and more short as they penetrated into this progressively densifying substance, being at such intervals reflected back by the elasticity against which they had to make their way.

Now, because of the vast depth of this insensible but light-generating envelope which surrounds the sun, and the consequent pressure to which its understratums are subject, these oscillating pencils would penetrate to a spherical parallel which they would be unable to pass in consequence of the compressive tension becoming so great as to reflect back the whole excitement, except such as would serve the condition of phenomena at the sun's solid surface, far above which is this reflecting or light-completing parallel, and intermediate of this and the sun's solid surface the density of this medium would so subdue the intensity of the excitement, as that on the sun's real or solid surface they only have the required quantity. Now, were we disposed to speculate, we might imagine the solariens oftentimes as opportunity served, looking out into space, and at far-off worlds, through those openings or cessations of luminous excitation which we call spots on the sun, and we would wonder if they have improved in the arts in proportion to the size of their world, so as that they have telescopes with space penetrating powers sufficient to take a peep at our little world, and the doings of its industrious denizens.

This spherical or luminous-exciting parallel in the sun's surrounding medium, although extensive, is but relatively small when we contrast it with the circumference of that vast sphere which comprehends all physical or affinitively affected matter belonging to the solar body, and on which was projected the metaphysical pencils of initial impulsions; therefore the pulsatory excitement when converged from this extensive surface to the parallel from which they are reflected back, must be greatly condensed as into the focus of a lens, and likewise intensified because of the compressed condition of the pulsating medium; and in this condensed and intensified condition they are reflected back by this very intensifying medium itself, to the surface on which they were first impressed, the metaphysical matter being there ready to instantly oscillate them to the earth or other bodies at remote distances.

Thus we perceive how it is that suns and other bodies are luminous, and that the planets or their satellites are not so, is because the insensible surrounding substances of solar bodies are of such depth and density as qualifies them somewhere in this depth, and before reaching their solid substances for receiving and getting up that intensity of excitement which is so essential in the production of luminous effect. Thus, too, we find it established beyond further conjecture or questioning that all the luminous bodies that we see in the heavens are not only solar bodies, such as our sun, but by this it is fully demonstrated that they are all necessarily surrounded with planets or secondary bodies, such as excite the luminosity of our sun, or otherwise they could not be luminous at all; and because of this luminous action not being self-generative, or having its source in the solar bodies at all, but continually received by the instrumentality of metaphysical matter from their surrounding planets while making their continual passages through this matter in their annual revolutions round the solar body.

Thus we find, too, by this sublime and sure system of inquiry, how the great truths of nature evolve each other, and to that extent as to make us about as familiar with the most remote objects, as we are with those among which we are more immediately associated; so that having the certainty of these truths associated with every thought of them, is surely well calculated to give us confidence in that high boon of Heaven by which we are thus enabled to look through nature up to nature's God; for in this we find one continuous connection through all to that eternal Being who was the originator of all, all being but links in this unital and God-like continuosity, of which the Being who gave it birth, and the being that can thus contemplate its grandeur in the consideration of its severalities, although infinitely far from being themselves equal, still to this eternal unity they both equally belong;

but as it is not with respect to man's immediate relations with the phenomena of nature that we are directing the present inquiries, but to ascertain how they came to be of that order to which his condition is so admirably adapted, we will therefore return to the consideration of light, which is so essential to him and all other created things.

Lest it may be questioned (because of our consideration of material molecules being so small), whether the atoms of this intermediate metaphysical matter in passing, as we say, over their hemispheres, could even be so oscillated as to cause luminous or any other excitement, we would remark that these light-germinating sphericals, by being on the utmost verge of physically affected matter, even although of the most feeble character, would be there subject to no pressure or other force save that of their own constituent affinities; these, therefore, would not be restricted in their construction of them into such compound characters as would be of considerable magnitudes when compared with the ultimate or first-formed molecules, and hence not subject to this question with respect to their excitable efficiency. By this infinite repetition of pulsatory action upon the sun's most exterior molecules, feebly affected although they be, we have seen that by the resistance of this effective matter how they are accumulated and condensed in its depths, from which they are again reflected back as thus intensified, and from thence oscillated to the earth's matter by the same medium that transmitted them to the sun.

While we thus deduce the means and processes by which nature effectuates the excitation which so wisely subserves the processes of solar activity, and conserves the condition of all associate phenomena, we are but pursuing the progressional seqüences in creative development which really could not have been otherwise; for as we find this oscillating action to be the way in which luminosity is excited on any surface, we likewise find that there could have been no other way in nature by which any such action could have been induced. The motions of the planets being the only activities in themselves incessant, causing the infinite and ceaseless repetition of these oscillatory impulsions upon the elastic envelopes of sensible bodies, they would in all instances be propagated to the depths of their several susceptibilities, from whence they would be again returned or reflected back to the bodies from which they originated.

Thus it is that planets are really illuminated, not by any luminous action really originating in the sun, but by the sun returning the excitation caused by the motion of the planets back upon themselves. We find the sun to be illuminated by the forward effect of the concentrating action thus excited by the planets, of which we are made sensible, and the planets illuminated by the reflected effect of the same action upon the excitability of their own enveloping matter. We have already remarked on the probable depth of the excitable susceptibilities of insensible enveloping substances, at which they would be so densified by pressure as to reflect back the exciting pulsations; for we would be by no means justified in the assumption that their penetrations downward would be indefinite, for as extension or quantity of physically affected matter necessarily implies pressure, as much might certainly be imposed as would make the fluid medium impervious to the farther penetration of light-exciting pencils. Now this is the very condition of the insensible and light-generating substances of solar bodies, for these bodies are involved in an outward ocean of this susceptible fluid substance, whose immense depth and consequent compression reduces its understratums to such intensity of tension as reflects back the light-exciting-pencils before reaching the solid substance of such bodies. But such is not the case with any of the planets, for none of their insensible envelopes are either so deep or dense but that the light-exciting propagations reach their visible and solid disks, which are the light-exciting surfaces of these bodies, before this substance becomes so deep or dense as to reflect these pulsations back; but were the planets or their enveloping mediums of equal magnitude with that of solar bodies, their reflecting surfaces would be, as with them, outside or exterior to their solid surfaces, to which but a small and subdued portion would penetrate.

From all this we perceive how it is that the planets of our solar system, however remote from that body, are so well illuminated, such not depending so much upon the quantity of luminous excitation received from that body, but on the depth and densifying effect of their own excitable medium, in concentrating and intensifying that which they do receive. Were it not for this, they would be but poorly supplied with light, indeed; they being at such very remote distances from that body. Their remote positions being favorable for the greater accumulation of the most lightly-affected matter of which these mediums of excitation are composed, they would be thereby more and more far-extending and the better calculated to gather up, concentrate, and condense these light-exciting impulsions, so as thereby to compensate for distance. The different susceptibilities of these depths and densities for intensifying luminous action is well expressed by the different colors and degrees of luminosity of both solar and planetary substances. We thus see by the prosecution of this beautiful system of research, how it is that even the unlooked-for explanation of much important phenomena almost force themselves upon our notice. We deduce this enveloping medium without reference to light. We demonstrate the planetary bodies to be the only substances in nature that the forces of nature can never let rest, and from which it necessarily follows that they must be the direct or indirect agitators of all activity. We have clearly proved that all energetic or physical matter must have been aggregated into substances bounded by spherical surfaces, from which it necessarily follows that all intermediate space must be occupied by matter that is still metaphysical. We have demonstrated the only effect that planetary motions perpetuated in space could have upon these two conditions of matter so very different. We have pointed out the only process by which planetary motions could beget this perpetual excitement; we have deduced all this to have been inevitably consequent from the conditions precedent; but farther we can not go, for there is nothing from which we can possibly infer that vision is consequent from these excitements which occasion it, but to these existing conditions *à priori* of vision organisms have been admirably adapted.

We assume that there will no longer be any difficulty in perceiving how it is that the solar bodies are the sources of light, which practically they are (as that is not light which is not visible), but bodies, they would in all instances be propagated to the depths of their several susceptibilities, from whence they would be again returned or reflected back to the bodies from which they originated.

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We assume that there will no longer be any difficulty in perceiving how it is that the solar bodies are the sources of light, which practically they are (as that is not light which is not visible), but virtually they are not; for we have seen that light-exciting pulsations originated with the planets, and it may now be readily perceived why they were not at once luminous, or, in other words, why the impulsions propagated inward from the surface of the earth's excitable medium do not at once excite luminous action, as they do on the solar body, in place of first acting on the sun's surface with no greater power than that operating at the same time upon the surface of our earth's exterior envelope, and yet that they should again return from thence with the exciting qualification so fully developed as thus to produce luminosity. It will be perceived why the outer surface of the sun's excitable medium is no better conditioned for the production of light than is the outer surface of that of the earth, the elastic force of the formative affinities of surface molecules being in either case by far too feeble and lax to effect luminous excitation on either surface, or even after they had been concentrated and condensed at the depth of the earth's visible or solid surface.

The surface of the sun's excitable medium can be no better qualified to produce that effect than the exterior surface of the earth's or any other planet's envelope. But although the exterior surfaces of all enveloping substances are thus equally alike ineffective of the direct excitement which occasions luminosity, it will not be difficult to perceive, that, because of the elasticity of the sun's surface molecules when impulsions are imparted to them in infinite repetition, they will therefrom be propagated into his enveloping substance, and to a depth where impact and intensity of tension would impede further concentrative progress, and very much intensify by condensation these communicated impulsions. And as the superficies of the sun's sensible surface, together with that of his compressive tension, is to that of his insensible surface, so will these impulsive pencils, by their convergence and consequent combination of effect, have acquired that acuteness which will cause visibility, and which, on their reflections outward and their actions on the understratums of the insensible surrounding secondary bodies, will produce therein by another reflection that action which we recognize as light. Thus it is that the sun's surrounding medium in some of its understratums becomes both visible in itself and the source of all luminosity, but certainly not by any innate action of the matter of that solar body *per se;* but by being continually excited up to luminous generating impulsions by the perpetual motions of the planets, and the convergence of the impulsatory pencils from the outer surface of the sun's far-extending envelope to his visible disk, by which convergence this condensation of excitement becomes there sufficiently acute to cause luminosity, when reflected into the understratums of our earth's and other bodies' surrounding envelopes. From all which we may safely infer that the dark spots so frequently seen on the sun's disk are occasioned by the effect of the relative positions of the luminous germinating bodies while in motion round this solar mass. In this light-generating system we see but continued examples of the consummate wisdom by which the simplest means are made available in effecting the sublimest phenomena in nature; for we have seen that the only necessarily continuous motion in matter is that of the planets; they in that motion cause an unceasing succession of light-begetting impulsions on that surface between the physical and metaphysical conditions of matter, and which are there too feeble or ineffectively acute directly to affect luminosity in the densified understratums of that medium in which the visible bodies of planets are involved, and on the outer surfaces of which we have found it to have been first induced; these pulsations are therefore required to be propagated into the solar body, as the only substance in which they could become sufficiently intensified to be effective of luminous action in the earth's envelope, into which they are again reflected. The solar body being of sufficient magnitude, and favorably situated for this effect, is thereby made the medium by which the excitation of planetary matter acquires luminous activity; for it is in the planets, and not in the sun, where the pulsations of light are first germinated, and they even as returning from him are equally ineffective of luminous excitation, until again converged and intensified in the understratums of our earth's enveloping medium; and to be satisfied of that fact, could we ascend but a comparatively short distance from the earth's solid surface, we would find the sun gradually disappearing from our view as we ascended toward him. The light-giving conditions of planetary envelopes are only in close proximity with their sensible surfaces, for it is to conditions there that the visual organs of sentient beings are adapted; therefore these sense-exciting vibrations can not be expected to prevail in efficient quality outward in this progressively rarefying medium, for in it they would equally fail to be found or required.

To be satisfied that all light-exciting impulsions are in the action of the matter which surrounds the sensible substances of planets, and not in the sun, it is only necessary to observe that he is situated beyond an ocean whose passive pencils could not be made to penetrate thus effectively into the positive conditions of the substances by which the earth and planets are surrounded.

The luminous susceptibility of the surrounding matter of secondary bodies, therefore, is made to depend on the quantity and consequent condition of the elastic tension of this enveloping matter, as excited into action by its condensation of the impulsatory oscillations returned from the solar body. Hence we perceive that, agreeable to this wise provision of apportioning to the several bodies, agreeable to their size and positions, the requisite quantity of this excitable medium, those planets most remote from the solar body by having accumulated about themselves the most extensive quantities of this conditioned matter, perhaps more than proportioned to their increase of visible bulk, the pulsatory excitement reflected from the sun, and converging from the insensible to the sensible surfaces of such bodies, with its consequent condensation of force and acuteness of energy, will amply and equally compensate them for their remoteness from the light-exciting body. By the same rule that the primary impulsions, imparted by the planets to the sun, acquire condensation and acuteness by convergence toward his center, these by being reflected back upon the planet's feeble exterior must acquire progressive condensation and acuteness as they penetrate into these planetary enveloping substances, and consequentl the deeper they have to penetrate before reaching the solid surfac of these bodies the more acutely intensified will they become.

There is no more difficulty in comprehending the possibility c concentration and consequent condensation of vibratory impulsi from the surface of a largely extended sphere or disk to one of inferior superficies, than there is in comprehending the concentration of luminons pulsations by a lens, an experiment with which every one is familiar. Thus, therefore, the proximity of planets to the sun is not a necessary prerequisite of their enjoyment of the blessings of light in all the required or essential quantities. Were this not so, the planet Neptune, and those circulating most immediately within his orbit, could not possibly exhibit the brilliancy they do at their remote distances from the solar body. Now with all these foregoing deductions and inferences of the derivation of light from the motions of the planets, we have the most positive assurance of what has hitherto been but conjecture, and that is, that every star in the firmament of heaven is a solar substance surrounded by its own systems of planetary and secondary bodies; for were not their luminous mediums excited into action by their surrounding planets, we could never have known of their being in existence.

From the special application of the atomic affinity to the matter which constitutes the solar spheres and their associate planetary systems, they could not possibly have been otherwise constructed than what they are, nor could that have taken place in any other possible manner than that which we have specified; and in virtue of this same application we find them illuminated in the only possible way in which such excitement could have been effected, and that by precisely such method and means as we have pointed out. These may be regarded as bold assertions, but the facts will bear them out, for they are, in their own intrinsic character, truths that are altogether insubvertible, and to which every other fact or phenomena, if permitted, will bear testimony. These planetary, solar, and astral systems or modes in which they are made visible, may have been infinitely varied by the attachment of energy to matter in any of the infinity of other ways in which it may have been done; but judging from the character of the Being in whom they had their birth, there could not possibly have been a better way, or he is the one who would have found it.

These, and all other phenomena, are rendered within our reach by application of the philosopher's ladder of three principal rounds, wisdom, matter, and energy. On these physical first principles we are able to elevate ourselves to the physical temple of infinity, and follow the formative processes in giving expression to creative thought. We are, by this safe rule of research, enabled to perceive the process by which the stars can, over such incomprehensible intervals, telegraph the tidings that they and their associate systems of secondary bodies are in their places, and at their posts, as links in the eternal unity of physical relations.

Calculations have been made with some considerable degree of confidence, that there are galaxies of stars so remote that such luminous intelligence of their existence as we are now receiving from them must have started on its mission more than sixty thousand years ago, even although traveling with a speed that is assumed to be but little less than two hundred thousand miles per second. Now to this we must certainly say that, however correct may be the calculation with respect to distance, there can be nothing more absurd than this calculation of either time or speed, for physical calculators who make such estimates further assume luminous pulsations to be propagated in undulous wavelets. Now this is certainly very conclusive evidence that they have not weighed well the subject they consider or discuss, for that there should be such undulous pulsations, necessarily implies that there must be a medium intermediate of such infinitely distant bodies, highly susceptible of sueh propagations.

Light-giving vibrations, propagated in undulous wavelets, presuppose the medium in which they are propagatable to be so elasticly tense as would be susceptible of such excitation; but certainly the light-giving vibrations are of far too delicate a character to be continuously penetrable of this space-pervading medium for sixty thousand years, or even sixty thousand seconds, without their total extinguishment; for excitement of this sort, or any other, can only be by a disturbance of the forces of affinity that formed the quiescence of the excitable medium, consequently such forces would have to be acted upon and continuously overcome at this rate of speed, and for such length of time, while there was nothing for this but the initial force of the luminous wavelets as first originated; it is certainly, to say the least of it, very unreasonable to suppose that a force so very inadequate could effect so much. We have already seen how infinitely susceptible the vast ocean of passive and metaphysical matter, intermediate of stellar bodies, is of being agitated into an oscillation of its atomic pencils by having to pass over the molecular hemispheres external of planetary surfaces; these pencils, by being of one continuous prolongation, because of the impenetrability of their constituent atoms, and their being subject to no impediment, must be instantaneous from the surface, to surface of bodies however infinitely distant from each other; this infinite passivity could be the cause of no resistance required to be overcome by this oscillatory action, so that the impulsive effect upon one end would be instantly effective upon the other. No power whatever would be required to project these oscillatory excitations however infinitely far they may extend, only for the reciprocating surfaces by which they are as instantly returned, there being no vacuity into which they can be elevated, only by opposing substances reciprocating that room with each other, and hence their continual agitation. Therefore, however inconceivable the distance or infinite the radiation of these pencils of light, or however minute they may be outward, they instantly go to where they are intercepted, and are as instantly sent back by some elastic surface susceptible of this infinite interchange of excitation, and this is the same wherever situated in the wide range of eternal space such returning surfaces may be.

Now, although these distances from bodies to bodies are, in most cases, inconceivable, and we may say infinite, so is the passivity of operating pencils; therefore the simple circumstance of distance is no possible objection; and when we contemplate the eternal continuity in which this medium of metaphysical matter connects all with all, of substances that are physically affected, we must not imagine objections that can not possibly exist, and the continuity of interchange be preserved. These are contemplations that require no ordinary expansion of the perceptive faculties of finite creatures, but as they are the truths of physical nature, and highly worthy of contemplation, the mind, by a familiarity with such subjects, expands itself into an appreciation of them in all their comprehensive sublimity—so that they not only become subjects of social relation, but means by which mankind may be enabled to approximate more readily to the character and physical conduct of his God.

There is opposition in any form of physically-affected matter to excitations of any kind, and consequently time required in the passage of luminous pencils through matter so affinitively conditioned; but there can be no opposition in the matter of visible pencils themselves, as pulsating from body to body in intermediate space, and in absence of all affinitive energy. The mind is so much familiarized with matter, in its most effective state, that it may be difficult at first to conceive of it in that condition as divested of all the characteristics that we are so ready to consider as essential to, and inseparable from, this substance, which, although abrogated of energy, would still have substantive existence, but not a faculty further that could make it physically effective. Now it can not but be conceded that this must have been the condition from which creative ability could have brought all that which we are so ready to recognize as matter, and it would certainly be inconsistent to suppose that all which still remained unaffected should be at the same time entirely inefficient in the physical productions of God. This eternal ocean of interstellar matter, being in its character metaphysical and infinitely passive, is not, therefore, to be regarded as vacuity because it has not a faculty attaching to itself, that is, of a physical character; but it should be regarded as nature's great nervous connection, by which the physicalities are excited into activity, and with such intelligence telegraphing effectivity, that the atomic tissue excited into action on the surface of any substance of affinitively affected matter, whether luminous pulsations or any other form of agitation, is therefrom instantly impressed upon those substances to which they are perpendicularly exposed, let such be situated wherever in the infinity of space they may. Now vast and inconceivably extended as this visual connection of substance with substance may be, the utmost that is either conceivable by us or visible to our sense of sight, however artificially enlarged our range of vision may be, it is still but an integrant part of ever-extending creation, with all its necessities and resources, causes and consequences, as parallel principles, the means and the ends simply and efficiently associating themselves for the furtherance of physical expression.

With nature as an eternally connected unity, nothing is little, nothing is large, nothing overmuch, or nothing deficient, no extensions too great or contractions too minute for her powers or her purposes. She has never been called upon for any special or final effort for the greater perfection of her progressional phenomena; with her a mountain is as easy produced as a mouse, a moon as a molecule, a solar system as any of its most insignificant members, a constellation as a comet, a galaxy of stars as the rings that encircle Saturn; or just as easy to produce the multiplication of galaxies that merge the ethereal blue of heaven in one eternal blaze of light, as to have formed the first spherical. All that is little, all that is large, all that is feeble, all that is powerful, all that is grand, glorious, and God-like in nature's revelations, are but the sensible expressions of creative thought, caused by the simple affinity of atom for atom, or rather by the triune principles of the eternal Godhead, as manifesting themselves physically.

Seeing that the light-exciting pencils, while acting from body to body in this interstellar matter of metaphysical character, are of but one continuous prolongation, and necessarily operating in reciprocatory impulsive oscillations that require no time in transmitting from body to body the induced impulsions—for while they are passing over the molecular hemispheres of one body, they must necessarily be making impressions on that of the other; and there being in nature, as we have likewise seen, no other method by which the transmission of light from body to body can be effected—our deductions may seem, on superficial observation, to be opposed to positive facts of observation; for it is now understood to be a positive and well-authenticated fact that light is not, as we say, instantly transmissible, for the rate at which it travels has been accurately measured, and it is found to require about sixteen minutes to cross the earth's orbit, or half of that time to travel from the sun to the earth—a distance of ninety-five millions of miles.

Now, as respects this seeming disagreement between our facts of deduction and this fact of observation with respect to time, we have only to remark that a moment's consideration will suffice to show that this apparent discrepancy between these two fact-finding methods is readily to be reconciled and accounted for. That it should take the luminous pulsations sixteen minutes, or some other specified time, to make their passage across the earth's orbit, is a circumstance as much to be deduced by our system of fact-finding, as that they make their passage across interstellar space in an instant, the one being no more in conflict with the conditions deduced *à priori* than the other; indeed, it is to be regarded as but another positive proof of the certainty of deduced conditions; for if metaphysical matter is at perfect liberty to pulsate the oscillatory excitement from body to body, however distant, in an instant, we can not possibly perceive how physical and affinitively affected matter could be susceptible of the same instantaneous action; for the constitutional forces effective of this physical medium of such excitability would require to be disturbed in their relations throughout the whole extent to which excitements could be propagated, and this would certainly require time; the very term to excite signifies some condition to be disturbed; and as physical conditions are all ruled by their affinitive forces, they would certainly present such opposition as would require both time and force to overcome this opposition of sixteen minutes; therefore time, for the passage of luminous pulsations across the orbit of the earth, is but confirmatory of the far-extending excitable medium that surrounds the solar body, and through which the pulsations signifying sixteen minutes of time had to make their way. The only wonder really is how they could have made their way at all. That such delicate pulsations should pass through affinitively affected matter, pervading to a great extent this one hundred and ninety millions of miles, without being totally extinguished, is certainly a mystery that still remains to be explained, whether they occupied sixteen minutes or any other amount of time. Sure we are that the theory of undulous propagation will never solve this problem; for it is certainly preposterous to suppose that the light of distant objects, with all its delicacy of pulsation, should be propagated from them to us, over distances so vast as some of the most remote objects are found to be by this form of affinitive action, and this through interstellar and energetic matter in some manner conditioned for such excitation; for, were it not energetic, it would be wholly unsusceptible of propagating undulous pulsations of any sort. But were it even susceptible, we do not perceive wherein undulous theorists have removed the difficulty; for we have not seen where they have said by what method such excitations are induced. This perpetual excitation of undulous pulsation would require to have a perpetual cause, or the forces into which they were propagated would speedily extinguish them, in place of permitting them to remain in full force and vigor for sixty thousand years, or any other time, while transporting to us intelligence of the infinitely remote substances they represent. Any one who will take into consideration the conditions of tension essential in any medium to render it susceptible of pulsations of this sort, must be well aware that there is no possibility by which they could be continued for any such times as are usually assumed for their transit from body to body. It would be equally absurd to assume that the visual excitement could be so propagated in metaphysical and perfectly passive matter, or in any other way than by the instant oscillation of its atomic pencils, as acted on by elastic substances between which it is intervened; for in itself it would be utterly incapable of all action, or motion, or propagative continuation of undula, or any form of excitement whatever; consequently of the only possible way in nature by which luminous activity can be transmitted from body to body, so vastly remote from each other, is that of which nature avails herself; for by this metaphysical matter being in endless continuity between body and body, and in contiguity with their surface molecules, motion excited in either of their surfaces is instantly transmitted to the other, which is as instantly made responsive; for no body could propagate a pulsation from their extreme surface that all others opposed to it would not instantly feel, however far in the infinity of space their positions may be, hence it is that no time can be occupied in the transmission of light or any other species of action from one body to another.

While we thus find that the pulsations of light would instantaneously act through interstellar space, by means of this oscillation of metaphysical matter, it by no means follows that its passage would be instantaneous through those oceans of effective matter that envelop suns and secondary bodies, and to which the attractive affinity is attached, for the molecular constituents of such substances being constructed by their own forces, and having at the same time a mutual affinity for each other, and a common center of gravity to which they incline, and which so necessarily imposes compressive impact, it would follow that such impact, affinitive action, and energy of tension not only involves the necessity of time for pulsations to combat such obstruction and propagate their way, but it would render these substances altogether impervious to the passage of such undulous pulsations as are hypothetically assumed to be the generators of visual sensation.

Now, by whatever method light makes its way through solar or other substances, sixteen minutes across the earth's orbit is certainly no measure of the velocity of light, when unobstructed by the affinitive formation of the medium in which it is transmitted, but is simply the measure of the resistance it meets with in making its way, and that can nowhere be but in the enveloping mediums that surround visible bodies; for, as we have heretofore observed, all physical matter must belong to, and form a part of, some body. It will now be perceived why it is that light requires so much time to cross the earth's orbit, and by that means has mistakingly had assigned to it this certain rate of speed which is supposed to be equally applicable to it, let it have come from what bodies it may. The surprise should not be, that it takes light about sixteen minutes to cross the orbit of the earth, as it has been thus observed to do, but, rather, that it should be able to make its way across it at all, through such energetic matter as the solar envelope must interpose to its passage. The time is here wrongly attributed to progressive increase of distance, when it should be attributed to progressive increase of density, as the bodies under observation send their rays more and more perpendicularly through the center of the sun's encircling envelope.

If observers will be more particular in making observations with respect to the same phenomena and the increase of time, they may be able to ascertain from this very approximately, what portion of the interior of the earth's orbit is occupied with the sun's enveloping matter; that is, what is the size of the invisible sphere bounded by its surface, through which the pulsations of light are obstructed in their passage. It is certainly yet to be found by what process light can be propagated through substances of such depth and density as that of the enveloping masses of the sun and planets. We have certainly by this time fully demonstrated the absurdity of the prevalent doctrine of undulous excitation being the cause of light, and that as originating in, and proceeding from, the sun. We would further observe, that the invisible envelopes which extend so far beyond the visible surfaces of the sun and planets are of such a character that no undulous pulsations from the sun or other body imparted to their outer surfaces could ever by any possibility have penetrated to their solid nucleuses, because the gradation of energy and impact is such, that while at the visible surface these substances are susceptible of very high excitement which diminishes to the least possible susceptibility at their extreme surfaces; for there they must be the most lax and least affected of all physical matter, and subject to no compression; therefore undulous excitements that would be so feebly pulsated there, would make but small progress down into the densifying depths of such substances. We conceive the very term undula to be an unfortunate one, particularly in the case of light-exciting pulsations, for it is evidently inexpressive of the conditions it is intended to cover. Undulous wavelets are only conceivable as being induced on the surface of fluid substances, while the pulsatory wavelets that are assumed to excite the sense of vision are in the interior of the fluid substance itself, and can not therefore operate as a succession of elevations and depressions, but must act, if at all, as a succession of spherical condensations and relaxations of the affinitive tension of the fluid substance itself, rapidly expanding themselves outward from the disturbing force.

Were it even possible that light-exciting undula, of from seventy to eighty thousand pulsations to the inch—which are the computed condensations of luminous excitement, and which must necessarily imply as many alternating degrees of tension or relaxations and condensations of the excited medium, could urge themselves outward and onward spherically, *ad infinitum*, from every point of every field of view, and at the rate of about two hundred thousand miles in a second—by what possible process could they indicate so unerringly, as the pencils of light do the infinity of points from which they are propagated, and which they so faithfully represent, we can not see how such sphericities could indicate so precisely any particular point from which they were agitated. Every circumstance in connection with the whole subject of undulous action, as being the cause of luminous phenomena, renders the idea more and more absurd, so as to excite surprise that it should ever have been entertained for one moment, and more particularly that it should continue to be the prevalent doctrine of the present day. Nature has never but one way by which she operates her phenomena, particularly when there is no possibility of such way being interfered with by any other operative circumstances, therefore there is but one way in which luminous excitation can be effected through both physical and metaphysical matter, and of that way she has necessarily availed herself.

We have seen by what process it is made effective in interstellar and passive matter, upon the exterior surfaces of suns and planets, or secondary bodies, but we have yet to point out by what possibility it is that the pencils of light can penetrate through the constantly increasing density of the external oceans of fluidity in which the solid bodies of suns and planets are involved. It would be but little less difficult for pencils of light to pierce through the formative affinities of constituent molecules of these excitable mediums, with all their elasticity and impact, as it would be for undulous wavelets of visual excitation to propagate their pulsations therein. The speedy extinguishment of either would certainly be inevitable, for luminous pencils could but little more successfully combat the quiescence of substances constructed by forces homogeneously conditioned, and under such pressure of impact and force of tension, than could the undulous wavelets to which light is so usually attributed.

That we may the better comprehend the formative conditions of fluid substances in which luminous pencils can penetrate to such great depths, while under such vast pressure and constituent character as would seem to preclude the possibility of their being permeable by oscillatory pulsations, it will be well, not only to urge the recognition of such enveloping mediums, but likewise to review the constituent character of such substances, and likewise of fluid substances in general, the better to understand what may or may not be their susceptibilities for the propagation of luminous or other exciting action.

Chapter Six.

Structural Arrangements—Solidifying of Matter—Cohesion—Rays of Light, how Separated—Action on the Optic Nerve—Heat, how Produced—Its Action on the Organs of Sensation—Magnetism—Electricity—Sound—Telegraphing.

There is certainly no department in physical nature, or any condition of matter more pregnant of physical effectivity, or of the most important activities, than is that of her fluid conditions, which are unquestionably the best calculated to subserve the formative subtilties of physical action, particularly in all their most incipient stages. It would, indeed, have been strange and unexpected for physicists to have formed any thing like a proper conception of the philosophy they undertake to teach, while they were altogether unaware of the character, or even existence, of these extensive mediums, or oceans of physical effectivity and excitability, in which all sensible phenomena are originated. It need not be wonderful, therefore, that so many of the phenomena of nature still remain a mystery, or, rather, that so very little should be accurately known of them, even after all the diligent investigations that have been made, and the continuous efforts to solve nature's phenomena. We are unaware of there ever having been more than a vague suspicion (but which seems now to be gaining strength every day) that there is some kind of a material medium, at least, surrounding the sun. No idea has been entertained with respect to the character, condition, and we may even almost say of the existence, of such vast oceans of insensible matter as we find must necessarily and demonstratively envelop these visible nucleuses, or sensible portions of every visible body, all of which being readily deducible from what we hold to be the first or fundamental principles of physics.

It may be here somewhat essential, in order to become the more familiar with the existence and condition of these substances, that we will find acting such an important part in the economy of nature, that we shall again simply review what we have already demonstrated their constitutional conditions and relations to be, or what these substances really are, as determined by that matter of which they are composed. In total disregard or repudiation, therefore, of every species of supposed repelling energy in the resolution of comparatively small quantities of sensible matter into the occupancy of greatly extended space, or, in other words, in the formation of ethereal, gaseous, or aeriform substances, we will proceed with our investigations, holding such assumed forces to be in themselves a physical contradiction, and significant of nothing but their own absurdity. We will, therefore, revert to matter, not as being made to occupy space by repelling power, but to its occupancy of space by atomic contiguity, however otherwise energetically or affinitively affected and associated; for, as we shall see, conditions are by no means made to depend on the relative proximity of atoms in the abstract (for in that respect all are in contiguity alike), but in the relative energy resident in such atoms, the most feebly affected and insensible surrounding the sensible as molecular nuclei, and resolving them apart. Therefore we have only to consider matter as assuming to itself the most simple forms in virtue of the energy of its atomic constituents, and whatever we find it to be in the positive construction of but one simple molecule, such will be the character of every other in the construction of the whole substance of such energetically affected matter; that is, all energetically affected matter, in virtue of its own formative affinities, would necessarily resolve itself into an infinity of spherical forms of similar character, but with forces variable in degree. Let us therefore ascertain what would be the determined structure of but one simple molecule as constructed by the affinity of its own constituent atoms, and we will in it have a perfect representative of the structural condition of every ultimate form. These atoms would arrange themselves agreeable to their own specific affinities into spherical globules, with progressive diminution of density or less effective energy, from the centers to the circumferences, and they would be larger or lesser, agreeable to the energy of their nucleus constituents, but neither their forms nor mode of structure would be different from each other.

The energy of these ultimate molecules, as formed by their own constituent force, would still make them about as variable in their gradations of power as that by which ultimate atoms were affected, without causing the least difference in the character of their several constructions, or of making them differ from each other in the positional order of their atomic constituents. Nothing, surely, can be better calculated to cause fluidity of substances than when constructed of an infinity of such forms, each being in itself a complete spherical with a common center, round which its constituents may be made to revolve without being much, if at all, obstructed by their own affinitive action; these structural affinities being equal at equal distances from their common centers would readily revolve; and the affinitive constituents, by being progressively more feeble toward the exterior of the spherical (whether it may be constructed of ultimate atoms or ultimate molecules), would thereby become less and less resistant, and therefore more susceptible of motion.

The mind may have some difficulty in the recognition of such structural arrangements among matter so infinitely minute, embracing even the very first forms that matter could take. A center and a circumference, with a progressive diminution of density or affinitive force from the one to other in forms so infinitely small, is certainly what we are not often called upon to consider; but if we wish to understand the ways of nature, and how she effects luminosity, and all other of her most subtile processes, we must understand the structure of the mediums she makes available in the exhibition of such phenomena. We can not expect to have sensible measure for the miniature depths at which nature fabricates her most incipient forms, notwithstanding which they may become as comprehensible to the mind as if our senses supplied the information, for there is but one rule by which she constructs forms, from their most infinitesimal to their most massive, and that rule is by no means difficult of recognition.

All fluid substances having thus the same root, we can apply the principle to sensible forms and ascertain their construction; and from that descend to first forms (even if they required to be multiplied by millions before they could become sensible), by the scale of analogical gradation, from these appreciable magnitudes to the least appreciable molecule; for the analogical relations will continue complete in this retrogradation down to the most ultimate molecule, which we have defined to be an infinity of sphericals, of which solar and planetary envelopes are the aggregated congeries in place of being the amorphous substance usually supposed; for, as we have already remarked, they would not lose their original identities in coalescence by becoming confluent in each other. The affinities by which they were individually formed being in their own matter, would be at all times, at least under ordinary circumstances, sufficient for their preservation, for that which constructed them would be sufficient to sustain them.

In any aggregate of such sphericals, therefore, the attractive affinity of each upon each would be so equable as not to disturb the constituent affinities of the matter of each for its own common center. The nucleus atoms of each respective molecule would be as well secured in the center of their small spheres by the reciprocating affinities of their own constituent atoms, as are the suns and planets in the center of the vast spheres they occupy. The attractive affinity of atom for atom, or body for body, being the governing rule in both cases, their positions would be alike permanent as determined by this same rule.

While we thus perceive that every primary spherical is preserved by the independent affinity of its own atoms, as arranged round their several centers of gravity, we must at the same time be aware that in every such aggregate, whatever be its magnitude, the mutual affinity of form for form would cause a common center of gravity for the whole, round which they would again range themselves in the order of their energy, the most ponderable forms taking precedence of those next in grade, altogether forming a globular mass of molecules with progressive diminution of density from the center to the circumference, as with first forms.

We perceive that the powers of these aggregating bodies would be cumulative in proportion as they appropriated matter to their own common mass, progressively extending their several spheres of action until they alternately effected the absorption of all the effective matter within their influence and power. And as in other fluid substances, the most ponderable molecular constituents would penetrate, by virtue of their own gravity, to such depth of position in the general mass as the common central power by the forces of its common affinity would assign them, hence it follows, that at every given distance from such centers of fluid spheres, let them be large or small, the energy of molecules would be of equal grade. Necessarily, therefore, the final condition of aggregates, whether of molecular sphericals or solar substances, would be a progressive diminution of density from their centers to their circumference.

Under this certain system of aggregating in mass it will be seen that the centers of suns and planets would be solid; not because of any mutual affection among the molecules themselves making them so, but from the incumbent pressure to which they would be subject, in consequence of being at, or approximative of, the focal center to which the whole combined energy of the mass is directed, and over which all superimposed matter would be compressive. It must be evident, that while certain central portions of such substances were thus subject to solidity, the progressive diminution of density and pressure would bring the solidifying forces to a termination of their effect long before the whole mass could be reduced to such a stubborn state. The solidification of a certain portion of any material substance is not effected altogether by the mutual affinities of either molecules or atoms in a direct sense, but is a condition of force consequent from the affinity between each component and the general whole, causing its constituents to crowd down upon their common center with a gravitating force of pressure sufficient to effect that condition in such of the component matter as was made susceptible (by the amount of its own native energy) for such solidity.

We have sufficient evidence that the earth and planets underwent this slow process of solidification from primary fluidity, but not of an igneous character, as is usually supposed; nor could they have been solidified until they had acquired the greater part of their present magnitudes, and had circulated round the sun, for otherwise there would not have been that adaptation of their forms to their diurnal motions that we now find.

All the molecular forces of these vast aggregating bodies having one uniform character and tendency, and being free when in the fluid state to exercise these functions of their affinitive being, and assume their relative positions (had it not been for circumstances hereafter to be considered), there can be no doubt they would have resolved the planetary surface into uniform planes, for in any stratum of parallelism from the center to the circumference of a sphere, molecular effectivity, as ruled by its specific gravity, must have been in all cases perfectly equal; hence, in whatever part of the general mass energy and pressure may have determined the solidifying surface, it could have had no inequality of level.

It requires but slight reflection to satisfy us that we can become acquainted with matter only through its being-in some stage of solidification; every species of matter we can recognize has some degree of solidity, and is still susceptible of more. Had we still other senses that would enable us to go farther into the subtilties of matter, many an obscure phenomena would thereby be revealed, but our senses are limited to such conditions as more immediately concern our physical well-being, so that we must penetrate the mysteries of unappreciable matter by deduction, induction, or mental conception. We are not to infer the great theater of activity to be either in the solid substances of bodies or in their sensible envelopes, but at the junction of the one with the other, where matter is in the transition state, or readily changed from one condition to the other. We conceive there is no situation where nature could be more affective of her phenomena than among matter of a fluid or a semi-fluid condition, intermediate between sensible solidity and insensible fluidity, or on what we call the earth's surface, which in reality is but the sensible surface. Matter in its most solid condition is unsuited, and insusceptible of ready transition of form, and the most insensible matter has not the measure of energy by which it can readily originate sensible substances. Therefore, at the juncture of the sensible with the insensible, we have a platform or stage where matter, by the mutability of its own conditions, is best qualified for nature's sensible enactments.

After the many examples constantly presenting themselves to our notice of the transition state of matter, while passing from the sensible to the insensible, and requiring keener powers than we possess to follow it in its recession, we surely may question the conclusion that the amount of matter in magnitudes is measurable by their sensible quantities; on the contrary, we arrive at the deductive conclusion, that the solid portions of all planets, secondary substances, or suns, must be the smallest part of their whole bulk; and if our senses do not verify our deductions, neither do they inform us of atmospheric pressure, and yet we are ready to acknowledge that fact.

The substance which imposes this pressure of sixteen pounds to the square inch has always been present, and yet how recent is the recognition of its pressure! and if this was the case with respect to the atmosphere, which is otherwise sensibly appreciable, how could we expect to be made aware of the earth's insensible quantity, even if it contained matter sufficient to impose sixteen thousand tons to the inch?

The pressure of such matter would be equal in every interstice of sensible or insensible forms, and would serve the purpose of fastening them together, as it could not intrude into solid particles, or such as had greater and more solidifying energy, or between their points of contact; it would press these points together, forming the force of cohesion necessary to solidity; and being pervasive of all forms, it would be very unlikely for our organs to recognize its presence; and although neither nature nor art can furnish any direct means for its measurement or sensible appreciation, that can be no proof against its existence. We have sensible evidences of the existence of the medium of force and activity in the exhibitions of its power and effect in what is called cohesive attraction, and of light, heat, and electricity; all these are but consequences of its presence and pressure, and of its excitable susceptibilities, as in its most immediate proximity to solid bodies; they having become so by its pressure, it would have all the elasticity of tension that such pressure could impart, and the best calculated for the propagation of such pulsatory action as would produce these phenomena; and yet to a great extent this very pressure, with the constituent affinities of this fluid, would restrict or circumscribe pulsatory action within a comparatively limited range.

Now, then, we will endeavor to show the process by which pulsatory pencils of light can be effectively propagated through its whole depth, particularly through the more compressed understratums, becoming at the same time more and more vigorous or intensified as they descend. When we consider for a moment the character of the molecular constituents, that they are a congeries of spherical forms infinitely multiplied with progressive diminution of energy and density from their centers to their circumference, we shall see there could be no better condition for fluidity. The constituent atoms of each molecule of a common mass being ready, on the slightest occasion, to revolve round their common centers of affinity, in whatever direction any force might impel, seeking only to maintain an equal distance from their common molecular centers of gravity, it follows that no pressure short of that which would produce solidity could much impede their revolutions, for they being in perfect parallelism, and opposed to no force, would find little opposition; for there could be little frictional resistance to the revolution of atoms round the spherical forms of which they were the constituents, and particularly the surface atoms of such forms, and least affinitively affected.

Now, this being the character and condition of the constituents of these vast oceans of insensible fluidity surrounding both suns and planets, we see no difficulty in understanding how pencils of light can be excited into oscillatory activity through the whole depths of this insensible but effective circumambient matter, but not by any means the constituent forms themselves, of which these substances are composed; for the central affinities of these would prevent their lengthened propagation from any impulsive point. But while luminous pencils can not be effectually propagated through these forms, still in such an extended mass, made up of such sphericles, there must be an infinity of parallel lines in every possible direction, and intermediate of the molecular centers where their native affinities would so neutralize each other's force as to leave the intermediate atoms free to act in oscillatory pulsations in the minute manner required in luminous excitation.

Now, as the exterior envelopes of all heavenly bodies are thus constituted, it follows that there must be in them an infinity of neutralent lines in which atomic pencils can play in such easy oscillating pulsations as can be propagated to their greatest depths with constantly increasing vigor, by infinite repetition of such primary impulsions as planetary motions would generate.

Should it be made a question why luminous excitement is less effective as we recede from the earth's surface, the solution will be found in the fact that this insensible matter must be less and less dense as it recedes from the visible surface, in consequence of the pressure there having caused the primitive molecules to part with much of their external or atmospheric matter, leaving those that now form their surface of such an increased grade of energy as would be susceptible of having effect upon the constituents of sensible substances, or on our organs of vision.

This grade of energy would become progressively less and less outward as the constituent forms are enabled to enlarge themselves by being relieved from this excess of pressure, and able to retain their respective atmospheres of less energetically affected matter. The molecular forms that could retain their constitutional enlargements would be the most feeble, and such as were farthest from the common center could have no effect upon sensible substances at the earth's surface, were they exposed to the greatest excitement to which they are subject.

But, on the other hand, however light their native energy, or fine their formative affinity, they would have force sufficient to elevate over their own hemispheres the atomic columns of interstellar matter that have no affinitive energy however elongated they might be.

We have now shown the conditions of the luminous medium, and the physical principles by which its action is generated on the surface of planets, and propagated by pencils of passive matter to the sun, where they penetrate to such convergent depths in his insensible envelope, that its density of impact and constitutional affinity becomes sufficient to reflect them back in all the intensity of their convergent vigor.

The passive medium of interstellar matter responds to the returning impulsions, and instantly impresses them upon the planetary surfaces from whence they originated, and by which they are propagated between molecular forms by lines of least resistance downward to the surfaces of solid matter, where the character and density of the transmitting medium has become best suited for effecting the visibility of surfaces whose elasticity makes every point a focus of radiation, in which is generated luminous pencils peculiar to the structural economy of the points from which they are reflected.

Almost every point in every surface is susceptible of being excited into light-generating impulsions, for they can not well be called reflections, as they are altogether a new order of visual rays excited into activity by solar action upon the infinity of light-giving focuses found in every field of view, and by which they are diversified with every minutiæ of color, light, and shade peculiar to the reflecting points. Now whether these modifications of light are attributable to a decomposition of the solar or prismatic ray is very problematical; be that as it may, we are well assured that the pencils which portray the forms of things, with their color and shade, are induced reproductions of excitation peculiar to the focuses which emanate them, their modifications being determined by the molecular or structural economy of the reproducing surfaces, and that, we should say, without any separation of the assumed parti-colored rays; for we here, with considerable confidence, venture the suggestion, that the impulsive action of any bundle of atomic pencils impressing the eye with the sense of vision, fall upon or pulsate at the same instant in producing the sense of white light; and that all other colors are produced by the atomic pencils not falling together, but in some measure succeeding with less simultaneous effect.

We hold that the unequal retardation which a pencil of luminous rays meets with in a prism to be an illustration of this fact, not by separating rays susceptible of inducing the different colors, but by making the pencils pulsate in more prolonged succession or unsimultaneously, the very effect which we would in ordinary cases attribute to the molecular economy of light-propagating surfaces.

From this, all the phenomena of the colors of light may be readily deduced, without considering it a compound made up of pencils pulsating in unequal periods, which reflecting surfaces can so readily decompose, and reflect only that by which they mean to represent themselves, or such as pulsate in unison with their own special peculiarity of form or shade.

This idea, though common, is too far-fetched or over-strained to be the order of nature, while, by the system we now introduce, every individual circumstance in the production of light harmonizes beautifully with the whole scheme of physical nature in its eternal unity, calling for no separate series of color-producing pencils, or requiring no special or extraordinary powers to light up in perpetuity the eternal luminaries of nature, for we think we have demonstrated that light in all the sublimity of its effulgent splendor is only the effect of that simple affinity which one atom has for another.

We have thus been enabled to narrow down the whole light-producing phenomena to the circumstance of visual excitement in its multifarious modifications, being occasioned by the molecular constituents of light-returning substances, every point of whose surfaces being a focus for setting in motion the luminous pencils in radiant lines, which, falling upon the eye and acting on its organized elasticity, directs vision along these lines to the points by which their pulsatory characteristics were imparted, and by which is truly indicated the objects they represent, and their relative positions. Now for the perfection of this grand economy of luminous propagation, and that it may serve the purposes of sentient beings as the most essential element of life and its enjoyments, we have all the peculiar mechanism of the organs of vision, with their wonderfully responsive adaptations and susceptibilities to the delicate impulsions through which we are impressed with the idea of outward objects. This visual mechanism we only now notice so far as it directly serves as a recipient of action by which ideas are excited. We find this special adaptation to consist simply in the organization of an outspread tissue of nervous network the most favorably situated from the center of the eye for receiving the impress of the luminous exciting picture. But as this retina or coating of nervous fiber, on which the outspread objects are projected by direct pencils, is not in itself the direct seat of sense, something more must still be necessary. Therefore we find this tissue of nervous fiber the recipient of visual excitement, gathered up into one collected bundle or cord, called the optic nerve, and unfortunately considered as one terminating channel or confluent column of nervous matter, terminating in unity, and turning all things upside down, as if nature instituted this inverted order for the sole purpose of amusing mankind with puzzling out the methods by which they must be erected into verticity.

Surely this charge of so strange a conceit of nature is an absurd and short-sighted one, saying but little for the philosophy by which it is entertained. When we consider the expanded or outspread tissue of optic nerve as only a screen for the reception of the luminous picture, or rather a recipient for its excitation, it certainly would be more natural to suppose these fibers passing, not into each other, but in a bundle into the organ of visual sense, and there again expanding and exciting that organ by the same series of impulsions received on the retina, and imparted in a tissue of terminating orifices; thus reproducing the pictural excitation as received upon the organ of sense, and in its vertical position.

These orifices or terminating points of excitement may be so situated in this organ as to induce the visual idea without the inversion of objects. It is very evident the impression of outward things can not be directly communicated to this internal organ of sense because of its situation. And the mechanism that can impress them on the mind is surely perfect enough to present them in their proper attitudes.

The organ in which the visual sense is immediately excited not being in direct contact with the exciting pencils, all outward objects must necessarily be impressed on the separate receptacles or fibers of the retina, in direct communication with the external world, by means of existing agencies, and which receives their impulsive impressions, and transmits them to the other termination of this nervous tissue in the immediate origin of visual sense to which the excitement is communicated, thereby inducing the idea of external things. The oscillating pencils of the outer medium, acting from objects upon the eye, induces in the nervous tissue of that organ a corresponding quantity of undulous vibrations, which, when transmitted to the seat of sense, reproduces the pictures as represented to the eye. We readily perceive that this transmitting fluid which forms the visual fiber could not be induced into oscillatory vibration analogous with outward impulsions, for being of an organic character, its formative affinities incapacitate it for that order of action, while it would not be disqualified for assuming undulous excitation. Hence we infer that visual sense is excited in undula and in upright order, although outward objects, and our organs of vision, have their connection in oscillation and inversion. All this is perfectly consistent with the economy of nature, and we feel unwilling to charge her with false presentations and inverted attitudes.

Where in nature can we find a parallel to this preposterous proposition of pictural inversion? Every phenomenon in physics is but in the perfect and inevitable progression of the orders preceding it, all being but parts of an eternal unity, which must necessarily embrace light in all its relations, and in this connection it is that we are thus able to deduce light in the true character of its mediums and motions.

Assuming that we now fully understand the philosophy of that department of physical law and action by which nature is revealed to our view in all its magnificence, and this terrestrial sphere made the fitting abode for sentient beings, we feel the better prepared to deduce the associate phenomena of heat and electricity, for we find them to be consequent from luminous action, and necessary links in the unity of physical progression and phenomenal projection. We can not but be aware of the vast importance of these principles, and their wonderful effects in the phenomena of nature. But who has yet decided their native character? What are they as ultimate and abstract existences, or what as associate phenomena? What, for instance, is caloric? As a principle of active being, has it an independent existence? or from whence is it derived? or what the fundamental process by which heat is produced? On what principle of procedure does the sun become its grand source, or sensible substances its ready recipient? How is it made effective for so many important phenomena besides sensation? Why is light often evolved by its action, and sensible substances enlarged by its means? Or why should it be evolved during the enlargement of explosive and expanding mixtures? Or how can frictional surfaces be made a source of its indefinite evolution? What is its action as an element of vitality? or wherein consists its generative principle in the mammalian economy of nature? Why should it impart an explosive momentum to certain mixtures, while others receive it undisturbed?

All these are questions which science has failed to solve. We have nothing decisive or satisfactory with respect to the intrinsic character of light, heat, or electricity. There seems but little more known now of the abstract or intrinsic nature of these great influences than at the creation of man. All remains still as hypothetical speculation. Science has discovered many ways by which their modifications of activity may be applied in enhancing the conveniences and comforts of life, but as respects their abstract or inherent character of derivation, science signifies no further than that the sun is their great and principal source. But we find nothing very satisfactory in that assumption, for we are ninety-five millions of miles from that body, and at that distance any action in him could have no effect upon us; but, even if it could, how account for the perpetuity of its action? This calls more loudly for explanation than the phenomena themselves which it is sought to explain; and such must be the fate of physical inquiry in every department while investigations are pursued in the usual and short-sighted order of inversion that is now the practice; that is, from facts of observation to facts of induction, philosophy must fall far short of deducing the series of conditions precedent of any observed phenomena in nature. She has her ultimate roots on which all has been erected, and her problem can not be satisfactorily solved without a proper comprehension of them and their character. By what process could we expect to arrive at a just conception of the character and stability of any structure were we altogether unacquainted with the material used in its erection? By this prevalent but mistaken system of interrogating nature we perceive how little has been elicited in the solution of her most important problems. We even by it know but little or nothing of those principles now under discussion, so essential to our existence and effective of almost every phenomena in nature.

We can, therefore, anticipate more success and less difficulty in finding safely the ways of nature by changing this mode of investigation, as we now do with that which pursues the forward process from the roots of things to their final erection. By this system of fellowship with nature we behold her in all her phases unfolding herself without effort, and successive phenomena following each other in the order of progressive sequences, subject only to their antecedents, thereby maintaining all physical relation in one eternal unity. What is most essential in this order of inquiry is, not to be mistaken in the character of the primordial elements with which we begin the investigation. We as yet have no fault to find with the efficiency of what we have laid down as first principles of physical effectivity, for they have served to resolve away all mystification from nature's nicest subtilties of action. They have furnished a clue by which we can penetrate and wend our way through nature's most subtile and intricate labyrinths, so that even the laws of luminous action and its perpetuity remain no longer a mystery.

For, as respects the perpetual activity of solar matter and the rotary motion of these orbs, we are enabled to deduce their derivation from, and subordination to, the perpetual motion of these planetary bodies; so that luminous action and its laws are but deduced sequences in the grand process of physical progression, from which likewise follow the phenomena of heat and electricity in all the complexity of their facts and phenomenal characteristics.

To know the nature of these important principles we have but to contemplate in retrospection the constituent character and compressed condition of the medium through which pencils of light are propagated, and we shall be satisfied that these pencils could not continue to oscillate in lines between the constituent molecules of this substance without disturbing the quiescence of their formative affinities, thereby effecting in and through them undulous action imparting itself to the mass because of its compressive tension and force of affinity.'

This undulous excitation must, to some certain extent, be analogous, as it is responsive, to luminous pulsation in its calorific propagation. The affinity of oscilliting atoms in lines of light, for the molecules to which they belonged, would be so effected by this action as to beget such disturbance as would cause other besides luminous oscillation, and which would follow in the form of undulous excitation. But this undulous excitation being analogous to the pulsations of light, and acting in an insensible substance, can not be sensibly effective under ordinary circumstances; but there is not in nature a more important or more general action in planetary masses than this one, insensible though it may usually be; for the vast ocean of excitable matter in which it is propagated, not only envelops the earth and planets, but pervades every sensible thing belonging to them, and from its susceptibility to solar-exciting influences must be constantly subject to such excitement throughout its whole extent and quantity, but at the same time it can not acquire an equilibrium of excitation, as the parts are unequally exposed to solar action.

But, notwithstanding the excitability of this enveloping ocean, it must, as a whole, be permanently equable with respect to any relative change of place from the uniform action of the energy common to the earth's whole mass, of which it forms a large portion, and by which its compression, particularly its lower stratum, is caused. The extent and uniformity of the compression of the lower stratums preclude the possibility of any considerable or extended relative motion in its own matter, particularly at the earth's visible surface, and while being so remote, nothing but luminous action can disturb its outer surface; although from the center to the circumference all pressure becomes progressively less, yet friction against the constituent sphericals with which the oscillatory pencils are in contact, must be all that can effect its relative motion, even in the higher regions of this substance, for there is nothing else by which it can be agitated. Where this substance is subject to the greatest compression, and that is at the earth's surface, it must be the susceptible recipient of a very high order of pulsatory action of undulous character, which action is again extinguishable by the elastic tension or force of the affinities forming the fluid in which it pulsates, and which is even the very cause of its propagation. Therefore any pulsatory excitement induced in this substance must be subject to diminution of intensity by progressive extinguishment on its receding from the exciting source; hence follows the inequality of its diffusion. The sun, being the exciting agent, can not be equally effective upon all, notwithstanding the rotation of the earth causing constant change in relative position. This medium, rotating with the earth, and being of equal tension at equal distance from the common center, will necessarily disseminate all imparted impulsions of an undulous character from the source of their origin, and hence it must follow, that because of unequal exposure to the sun's action, there must be a continued flow of excitement setting from the solar source of such action toward the regions of its extinguishment, or to the more quiescent quarters of this excited and conducting medium. That nearest to the plane of the equator being most exposed to the exciting action of the perpendicular pencils of light, must necessarily be charged with a constantly generated influx of this highly induced excitement, which, by its constant endeavor to disseminate or equalize itself by a discharge into more quiescent quarters, would cause a continual current setting from this source of excitement toward the poles of the earth, with, perhaps, such variable tendency as may, through certain periods, sensibly deflect it from a perfect coincidence with these points, and now known as the variations of the magnetic needle.

Now, although that by our senses we are wholly unable to appreciate this highly excitable and all-important medium, or even the existence of this constant and diffuse action, we have but little better proof of the existence of any thing than we have of this substance as furnished by its effects in the inducement of luminous, electric, magnetic, and calorific phenomena; for it would be absurd to consider either of them as principles active, *per se*. When they testify to their own existence, they equally tell of the medium that is susceptible of their excitation, for they are in themselves but the effects of highly excited action in a medium that can make it appreciable; and when the electric or magnetic excitements in this fluid are equally diffuse, they are as inappreciable as the medium by which they are pulsated; and in this condition physicists are in the habit of looking upon them as latent, when with as much consistency they might say that the shades of night were latent sunshine. Action and inequality in its diffusion are but the sensible expressions of this substance, and if the actions are different in character, so is this substance different in constitution.

Every form of physical action whatever must have a material medium for its exercise; for were there no substance there could be no excitement, and no substance could possibly be susceptible of such excitements as those that exhibit light, heat, electricity, and magnetism, unless under intense tension; therefore, apart from our other proofs of these vast oceans of elastic and highly excitable matter that we assume to belong equally to all solar and secondary bodies respectively, we have abundant testimony of their existence in the phenomena they exhibit, for we certainly could have no light were it not for pencils of atoms in perfect contiguity, oscillating from body to body and object to object, and effective upon our organs of sense, because of their disturbed affinities. There could be no calorific, electric, or magnetic exhibitions of action were there not a substance highly susceptible of being excited into undulous activity of the most delicate acuteness. For these modes of activity there could be no substance susceptible unless under such degree of elastic tension as would be sufficient to cause the pulsations to vibrate light, heat, electricity, and magnetism; for they are certainly associate forms of action, and in the same excitable medium, for we find them often (and we might almost say always) inducing each other. Now such a qualification could not be imparted to any substance except by excessive compression, and such compression could not be imposed but only by the superincumbent pressure of matter seeking the common gravitating center, which certainly implies a far-extending substance suitably conditioned. Let this great truth of nature be but once admitted, and these, as well as many other inscrutable phenomena, become easy of explanation; and we see not why this admission should not be made, for there are in the consideration of these phenomena alone enough to be elicited in conclusive substantiation of this great physical truth; and finding that such an enveloping and invading medium is essential for the excitations that enliven our earth, we will by implication or inference readily assume a similar accompaniment to every other heavenly body.

The proper position and portraiture of objects could only be presented by pencils of matter being projected in oscillating pulsations between points of vision and our organs of sight, they being excited into a sense of them by their elastic susceptibility of reciprocating such action. Certainly no one having considered well all the necessary characteristics of undulous pulsation can have any great confidence in such form of action being the exciting cause of vision.

It is highly essential, not only that this fluid medium should be recognized, and its susceptibilities assented to, but that these properties or forms of action should be well considered and understood, for the most important phenomena in nature are depending on these conditions and the action therein induced, they being the great source in which are generated all the activities of nature, and therefore may be considered as stimulating into being the very organisms by which these activities are observed, being prolific of life and all that makes it pleasurable.

Assuming, therefore, that such a fluid substance envelops the earth and invades every sensible thing, when we contemplate the character of such a substance, and the only possible conditions of such excitements of which it is susceptible, we will find that in a fluid substance thus suitably conditioned there could be induced but two distinct orders of action, and that the primary source of such excitements is in planetary revolution, or even suppose in the sun, still there is but one way that solar action could excite this enveloping matter of our earth into luminous activity over the extensive interval of ninety-five millions of miles which separates these bodies, and that is by oscillatory pulsations in the manner already pointed out; for in the intervening medium no other possible activity could pass this extensive chasm; so that by the oscillatory process and its perpetual inducement, as already indicated, we have the means, and the only means, that can be effective from one body to another of the luminous phenomena; for the intermediate metaphysical matter could by no possibility be induced into any other order of action, and the physical matter of these enveloping mediums could not so freely and equally pulsate any other condition of excitement by which it may be supposed that light is propagated. This order of excitement we can readily perceive to be possible in both the physical and metaphysical mediums; but the only other form of excitement of which physical matter is susceptible being that of undula, this undula could not possibly pulsate in metaphysical matter; and were intervening matter physically conditioned, its affinities would not by any means permit such undulous excitement to pulsate its way so rapidly from body to body; neither could they operating in an elastic substance cease their action the moment the exciting force was no longer effective.

Now that we have deduced and fully considered the substance and its excitable susceptibilities in which alone luminous propagation can be pulsated, and likewise the medium and mode by which only this pulsatory action can possibly be transmitted from body to body over intervals so vast, and at the same time perceiving the total insusceptibility of this intervening medium for the transmission of any other possible order of sensible action whatever, we thereby arrive at the further fact which is thus conclusively decided, that the sun is by no means the direct source of heat that it is so much the practice to suppose, but that heat is an action in the same luminous existing substance, induced by the sensible substances as vibrating in response to luminous pulsation; and we may be further satisfied of this fact, by observing that the calorific excitement progressively ceases as we ascend above the sensible substances and surfaces by which it is induced. The susceptibility of this enveloping substance for any other species of excitation than the oscillation of light-inducing pencils, we have found to consist exclusively in a vibration of its own constituent and intense tension in the propagation of impulsations of what are usually called undula, this being the only further agitation of this substance as sensibly expressed, or that is possible in an elastic medium subject to such compression, as this medium common to the exciting actions must be. These calorific pulsations operating in undula, although associated in a very considerable degree with the excitements of light and electricity, are a different order of impulsions, induced, as we have seen, by sensible substances in their sympathy with luminous action; for all reflecting substances, however solid they may seem, have such elasticity as not only renders them susceptible of responding to the luminous pulsation, but there is thereby likewise induced in their own constituent matter another order of excitement which is recognized as heat, but this induced excitation is by no means of as acutely delicate a character as the light and electrically inducing impulsations, but at the same time graduating through almost every degree of intensity as they become more and more condensed.

The most important and widely diffuse excitation induced by luminous impulsion in this common medium of excitability is that having least sensible connection with sensible substances, and therefore least observable, and which, for convenience sake, we will call the magnetic, being that form of infinitely diffuse and delicately acute action of which the magnetic effect is the sensible expression, showing its direction to be to that of the poles of the earth, the equatorial regions being the most effectually charged with this excitement, by their being more immediately subject to the exciting action of the sun; for this direct effect of pulsatory action transmitted from that body being an oscillation of what is really the constituent matter of this effective and excitable substance, must cause in it at the same time a pulsatory vibration of its affinitive and elastic quiescence, in unison with that of its oscillatory pulsations, which will necessarily propagate itself in that direction where this action is least prevalently induced; for this excitable medium being so infinitely tense, will necessarily cause the rapid transmission and diffusion of such acquired action, and toward the poles of the earth, being the direction of its progressive extinguishment, and consequently the directions least resistant, which will cause constant currents of this excited action to be propagated to these quarters. With respect to the inequality of this induced action, it will not be difficult to perceive that more immediately toward the equator, and at the junction of the earth's sensible with this insensible substance, there would be much the greatest excitement and constant accumulation of this rapidly generating action; and as this susceptible, insensible, and subtile substance both pervades and envelops the sensible portion of our earth, each must be very highly charged with this induced action, and more particularly in the regions that the rotation of the earth turns more directly to the sun. But while this medium is equally susceptible of being highly charged with this excitement, whether in the earth or superior thereto, it is not equally susceptible in either position of conducting off this excess that is so constantly generated, at least more immediately under the sun, for that which is superior to the surface is so affinitively associated with the matter of our sensible atmosphere as to render it a much more unready distributor or transmitter than when in the rocks of the earth, or the aqueous matter therein, with which it is in no affinitive association, and from which atmospheric matter is excluded.

This magnetic excitement being constantly and excessively induced under the sun at the equator, and the earth revolving on her axis at the same time, this excessive excitation will, therefore, flow off in the directions least charged or obstructed, which we may infer to be somewhat in the opposite direction to that of the earth's rotation, but more particularly and generally toward the polar regions, to which its tendency must be decidedly the most prevalent, because of the quiescence caused there by its progressive extinguishment. The excessive tension of this excited medium would enforce the very rapid transfer of this excess, were it unobstructed in its transmitting susceptibilities; but we have seen that when associated with the sensible atmosphere, or other sensible substances, it forms such affinitive relations therewith as very much incapacitates it for such transfer, because of its being in this relation more insusceptible of speedy response to this acute action, and consequently less ready in its propagation; therefore in the common atmosphere it may be regarded as a much worse conductor of this action than when in the earth or rocks, from which this common atmosphere is in a great measure excluded. Therefore among all the sensible substances this excitement of this insensible substance will seek to equalize itself by a passage in those that are least affinitively or constitutionally obstructing; and hence it is that a magnetic bar of steel, when delicately balanced as is the magnetic needle, will be made choice of, because of the medium in it being the most free to act and throw off in equalization to less excited regions this acute and transferable action; and although the path of this general current in the more or less obstructed earth and atmosphere may be circuitous to the poles, having at the equator a strong tendency in opposition to the earth's rotation, this, on entering the needle longitudinally, will be in revolutionary action round that ready conducting bar, imparting to it by spiral convolutions a positive latitudinal direction, such being that of decidedly the least resistance, and the shortest route to less excited regions, to which it thus avails itself of this conducting instrument as far as it goes, the frictional action of this excitement being sufficiently forcible to give direction to the nicely balanced bar it is traversing, and which makes it the useful and important instrument it is.

From what we have now considered, we not only perceive why the magnetic needle directs itself to the north, but we likewise readily deduce its declination or dip as it approaches high latitudes, for this highly condensed magnetic action, being by the agitation of an affinitively constituted and highly excitable fluid substance that would otherwise be in a state of quiescence, must necessarily be an extinguishable quantity, constantly and progressively subject to reduction by those very forces of which it is the disturber, they being the constituent affinities by which this excitable substance is constructed, and of whose existence this very action is the most sure evidence, not only of the substance itself, but of its affinitive relations having been disturbed; a restoration to quiescence by an extinguishment of this excitation is what must be continually sought for by this substance, and more particularly and effectually in high latitudes removed from the exciting cause.

On the propagation of this excitement toward the poles, therefore, there could not be a continued parallelism with the earth's visible surface, for as this excitement became extinguished in the earth, the parallels in and out of it would no longer be equable, and the exterior excitations would turn in to restore the equilibrium, thus giving dip to the needle. This excitement so constantly generating at the equator and passing off to the poles must become progressively extinguished on its passage, for it could not constantly accumulate in convergence at the poles, its strongest tendency being to equalize itself by passing to the most quiescent quarters. Neither would it readily pass out through the common atmosphere into higher parallels of its own medium, the atmosphere being, as we have seen, a very indifferent conductor, therefore it must begin to penetrate the earth, because of its extinguishment therein, long before reaching the poles, for much of it could not converge to these points. While the earth in high latitudes becomes more and more its ready recipient and extinguisher, being less and less under the influence of the exciting cause, we must know that its tendency being north and south, it could not pass round the poles and return in opposition to itself; but there are, at times, such accumulations of this excitement in polar regions as to be sufficient to make its way through the imperfectly conducting atmosphere into its higher stratums, in which it discharges itself, and in such cases the phenomenal expression known as the aurora borealis, or polar lights, are the sensible sign.

Thus we have it clearly demonstrated why the magnetic needle should have a polar dip. Indeed, we thus find deductions not only demonstrating this current of activity, but likewise the character of the medium susceptible of such excitement, the dip of the needle bein but the sensible expression.

Passing from the general order of this insensible diffusibility of such action, and for the present any consideration of its effective agency in the structural economy of constituent things, we will endeavor to deduce what are the special circumstances by which its powers are so concentrated as to become sensibly effective on sensible substances, and by what conditions it is induced to make its election so as not, at all times and under all circumstances, to act in obedience to the law of general diffusibility. In order to do this, we will avail ourselves of the most conspicuous example of its exercise of the elective franchise as manifested in the thunder-cloud and lightning's flash.

To ascertain the process by which certain portions of the sensible atmosphere are charged or discharged of this excitement, we have only to reflect on the very excitable nature of the insensible atmosphere, and the transfusibility of which it is susceptible. But as this insensible becomes incorporated with the sensible atmosphere near the surface of the earth, its susceptibilities for transfusion are so much reduced as to become almost a non-conductor. Hence those portions of this compound atmosphere more immediately exposed to the sun's direct effect at the earth's surface must become very considerably surcharged, not only from increased quantity received, but from increased inability to throw it off. 'Tis a well-known fact, that caloric increases the volume of any substance, and particularly of the atmosphere, which, as it becomes heated at the earth, will, from its increased buoyancy, ascend into regions of its own specific gravity, transporting thence the excitement received at the surface.

Another well-sustained fact in connection with this process is, that this highly excited atmosphere in hot regions has its affinity for aqueous matter very much increased, and receives its particles as components of its enlarged volume to a considerable extent, and these aqueous particles having a capacity for excited action conduce to its greater equalization. The general principle is well understood by which this constantly expanding atmosphere, under the exciting influence of a tropical sun, is as constantly made to change its place with other portions that are more condensed. The atmospheric currents caused by this transposition and transfer often bring into proximity large quantities of atmosphere the most highly charged with this excitement with others having the least, and when these intermingle, part of the excess of the one being transferred into the other, this reduction of excited action lessening its capacity or affinity for the aqueous matter with which it was associated, and that aqueous matter left to the exercise of its own formative affinities, constructs an infinity of more condensed sphericles, constituting a cloud of aqueous vapor, which, being a more ready conductor, although a less ready retainer than the unmoistened atmosphere, serves as a medium for the transmission of this concentrated excitement and its more general diffusion. Every impulsive discharge of this excited action from the atmosphere in which it was the most highly energetic to that of comparative quiescence, or where least active, whether as evinced by the lightning's broad flash or its forked coruscations, must necessarily facilitate its further transmission and transfusion by the rapid condensation and outspread volume of aqueous vapor it causes, whose conducting powers by expansion induce still further transfer into more quiescent quarters of this over-charged excitement.

In northern and temperate regions this aqueous condensation is by a more slow intermingling of the atmospheres, and less exhibition of electricity or rapid falls of rain; but as we descend into low latitudes, this general and more progressive diffusibility of excited action becomes progressively less prevalent, because those portions of the atmosphere which are the medium of its more immediate reception, and by it excessively charged, are, when suddenly brought into proximity with portions containing but little, suddenly discharged. The aqueous matter sustained and sustaining this high action is thereby precipitated to some very considerable extent, by which condensation it becomes less capacitated for sustaining this excitement, but thereby forming a conductor through which discharges make their way with a rush, exhibiting themselves in the quick flash or rapid coruscation, as if by a breach in their barrier-wall. Every discharge of this high excitement produces others by the projection of conducting facilities (in the form of aqueous vapor) still farther into the excited regions, until general equalization is restored.

We find, from observation as well as deduction, that one simple discharge of the electric excitement is seldom sufficient to restore the required equability to all parts of the atmosphere, therefore they are repeated again and again, each escapement extending the facilities for a further discharge by leaving a large portion of aqueous matter alone to be condensed by the force of its own affinities; for we can not suppose that the action which exhaled so much vapor on its diffuse generation, could carry it along on its suddenly condensed exit. All this is certainly very conclusive of an excitable medium surrounding our earth other than our common atmosphere. Though it is usual to ascribe all these phenomena, of the exhalation, condensation, and fall of aqueous matter from the atmosphere, to calorific influence, there is no intimation of what this influence consists; and that no doubt has considerable agency in the exhalation of water, so far as effecting the divisibility of its particles, but no farther, for by its resolution into aqueous particles, water becomes in a condition to be appropriated by the formative or reformative affinities excited into action, and sustained by the constantly increasing electric impulse.

It would certainly require more than a seeming coincidence of cause and effect to convince any reflective mind that, from a condensation of translucent atmosphere to all the varieties of its clouded aspect, from the drizzling distillation of dew to the precipitous condensation of the thunder clouds and the downfall of their floods of water, are all attributable to the presence or absence of this or that much heat or caloric, free, or latent, as may be supposed; that being in itself a quality of the least determined continuance of either of the undulous excitements of this substance, being induced, as we have seen, in the associate condition of the sensible with the insensible atmospheres, subject to rapid reduction and extinguishment by the constituent forces of the very medium of its emission or propagation, whose vibratory disturbance and effort at restoration it is but the sensible effect, and therefore this action being induced among matter of a more sensible character, is thereby more sensibly effective and subject to more sudden reduction. The formation of clouds, the precipitation of rain, the concussion of the atmosphere in electric storms, and most other meteorological phenomena, are attributable to electric, and not calorific excitement. And the exhibition of light and heat, although not causing the phenomena, afford sensible confirmation of what it is. Temperature is of too transient a character, and subject to too many vicissitudes, to be calculated upon, as especially chargeable with so important a mission as the rarefactions and condensations of the aqueous matter of the atmosphere, and the when' or to what extent the earth will be blessed with its fertilizing showers.

Let us follow up but in one instance the force of this calorific hypothesis, and we shall perceive its absurdity. It is well understood that the highest temperature on the earth's surface, as a general rule, is where most exposed to the sun's rays; likewise that the exhalations of aqueous matter from the earth's surface and from the ocean is, in such regions, of very considerable extent. Now, this high temperature, while begetting in the atmosphere a capacity for the reception of large quantities of water with greater specific gravity than itself, does, at the same time, induce such a metamorphosis of its constitutional economy, as to reduce its density by enlarging its volume, whereby it is crowded upward by the superior gravity and pressure of that by which it is replaced, so that there is a constant ascension of this aqueously compounded and constantly expanding atmosphere. If, therefore, caloric were the only originating and sustaining influence by which the incorporation of aqueous matter in our atmosphere was effected, and its interfusion sustained, we could not possibly, on any part of the earth's surface, escape having a continual canopy of cloud above us, as these exhalations were progressing below; together with a constant distillation of their condensing vapor consequent from the progressive diminution of temperature, by its extinguishment, either while ascending from the surface or when passing to the poles; which directions heated atmosphere is understood to follow, as the general rule of its differential conditions in the occupancy of space. Whatever we may suppose to be the affinity or force by which heat exhales moisture, if it were not transferred to some other power, on what principle can these relations be sustained? For, so far as we can fathom, condensation would be the consequence of a reduction of temperature; for were increase of temperature both the evaporating and sustaining power of the increase of dissemination, surely a reduction of temperature would cause a corresponding reaction, and sensible condensation of these exhaled waters and their return to the earth in continued rains, particularly in regions of low temperature.

As reasoning in refutation of this general calorific doctrine we may be reminded of the principles or axioms assumed and embraced in prevalent hypotheses, which is, that heat is radiated upward along with the ascending atmosphere of whose expansion it had been the cause, and that it would continue its association and still sustain such intermixture and expansion, for although less sensibly evolved as it attains altitude, or progress to the poles, this is accounted for by its becoming latent in this atmosphere.

Now, as we hold heat to be but the sensible effect of the excited activity of some substance, and that substance in itself insensible, we should as soon conceive of latent light, latent moonshine, or latent motion, as to call the quiescence of any substance latent activity. Calorific action is certainly a very important solvent principle in the atmospheric department of nature's great laboratory, for by its more sensible and effective excitements the reduction of solid or liquid substances are more readily effected, and their constituent matter made subject to the effective action of the more delicately disposed, but no less effective electric excitation, by which the molecular constituents are sustained and better prepared for their transformation into new substances.

The sun's rays, as we have already seen, excite sympathetic pulsations in the insensible atmosphere, which in their condensation and sensible exhibition are recognized as electricity. This highly prevalent and perpetuated action is at the same time generative of a more forcible but less continuous agitation among sensible substances, such as our atmosphere, and as they are in association with the all-prevalent and electrically excited insensible atmosphere, they are the more immediately subject to its disturbing influences, which cause that form of action recognized as heat.

Therefore heat, being abstractly but the sensible effect of vibratory activity in insensible substances, and by them subject to rapid reduction, would be but poorly qualified for the important charge of apportioning out sunshine and shower. The disturbed affinities, which this action is but the effort to restore, must be energetic enough soon to extinguish such impulsions when their exciting cause was removed, and likewise to prevent any very extended propagation, for a sensible substance must have qualities stubborn enough to overcome any series of such delicate pulsations as could be imparted by luminous pencils or electric pulsations. And observation fully confirms this fact, for with [illegible] the means that can be applied in the production of terrestrial heat, by combustion or otherwise, its sensible propagation is bound within very narrow limits; not having the association of electric excitement, which is a subject of solar development, it has no renewing stimulant, and therefore soon terminates its action by the affinitive force of the substances in which it is operative.

Much heat is required to resolve water into steam, and the same quantity is again evolved on its recondensation into water; but not so with the aqueous matter of the atmosphere, even when condensation is on its most extensive scale. There is no determined or sensible evolution of heat, even when a cloud of aqueous vapor is formed or condensed into rain, neither is there any appreciable abstraction of caloric from other substances, even when the cloud of steam is reconverted into invisibility; neither case sufficiently indicates heat as having been the operative agent. When water itself is resolved into gaseous invisibility by a great accession of heat, as in the formation of steam, and when such steam makes its exit into the atmosphere, it gives out a great portion of its heat, and is reduced into visible vapor, forming a cloud of reflecting sphericles; this condition is again most readily changed by electric excitation into invisibility, requiring but little or no heat for this second expansion. In this process no heat is evolved or involved, other than the ordinary temperature, leaving the future condition of such partially condensed steam to be determined by the electric excitement, and the effect of this excitement is what is usually taken to be (and is erroneously called) latent caloric.

Our relative sphere of action is in that stratum of the earth's matter in which the transition process is the most prevalent, and the luminous, electric, and calorific actions the most intimately associated, because of the substances being there the most suitably conditioned and susceptible of reciprocally generating each other; and at this juncture of the solid with the fluid quantities, this common medium of pulsatory action is there most susceptible of being excited into such action as can have most effect upon sensible substances. This medium in and by which such orders of action can be made effective upon sensible substances, or that can itself be excited into action by such substances, being there in some measure affinitively and immediately associated with them, must partake to some extent their energy of character, otherwise they could not be so readily effective of each other's excitation; the energy this medium has at this approximate juncture acquired, is attributable to the increased density at this depth; being under the pressure of all this incumbent aerial ocean, and constituted of its most gravitating matter, is thereby the best qualified as an intermediate agent, by which the most exterior and etherealized matter of the earth, as well as all exterior bodies, is put in active communication with the most solid and sensible matter of the general mass.

The most ponderable and effective of this fluid matter will, by the force of its own gravity, be found encircling the solid portion of the earth, and occupying its depressions, and ready at all times to assume other forms or associate conditions as circumstances serve. Associated as mankind have ever been with this solid and transition state, and its concomitant phenomena, and not being aware of any such general medium of action or power of resolution, it is not surprising that so much of nature's phenomena should be ascribed to the action of heat; for physicists finding or fancying that to be so generally effective, and knowing so little of its true character, they attribute to it most of that for which they can not otherwise account. In all the subtile processes of nature, heat has a considerable and important agency, at least in the preparation of the materials for associated and formative effectivity; but in nature's nicest economy and general construction of her forms, other and more uniform order of action would seem to be essential; for it will be observed that while heat has much to do in the chemical department of physics, it will at the same time be perceived that the chemical affinities usually require for their effect a more delicate and continuous excitation, often expedited, no doubt, by this associate action. Light, heat, and electricity are terms familiar to all, and so are their effects upon sensible substance; but that is all as yet known of them; notwithstanding the many inquiries made respecting their native character and nature of their action. Before there can be a full realization of the character and conduct of all the modifications of these three important principles of action, there must be a full recognition and appreciation of the all-invasive, invisible, but highly effective medium, whose presence and action is instrumental in, and essential to, the origin of all nature's most subtile, effective, and phenomenal processes, and as being in itself susceptible of this series of simultaneous excitements effective of the above-named species of sensible action.

We have now fully demonstrated the existence of this medium, and have contemplated the only continuous power in nature by which its luminous excitation is perpetually effected, and have deduced the illuminating process to be the oscillation of atomic pencils, intermediate of the infinity of molecular sphericities which constitute this intensely qualified medium of excitability. We have observed the reflective process by which it is propagated from object to object, as effecting their sensible recognition. We have seen that this oscillating action of the surface-atoms of susceptible molecules could not (because of their affinitive tension) propagate themselves without causing at the same time (in the substances of which they are constituents) a diffuse excitation of undulous pulsations of kindred acuteness with the pulsatory pencils of light by which they are induced, this general action, when condensed, or operating in suitably conducting substances, being recognized as electricity, magnetism, etc.

We have observed that this induced action, by its continual endeavor to diffuse itself equally in this general medium of excitability, will propagate itself in a constant current from the equator to the poles, and inclined in the opposite direction to the earth's motion.

Our sensible atmosphere, as effectively associated with this medium, makes it a less ready propagator of these electric and magnetic pulsations, and consequently obstructs the general transference of any excess of excitation; hence is it that substances pervious to atmosphere are bad propagators or transmitters of such excess.

This medium as acting in proximity with the earth's sensible surface, and in association with the sensible atmosphere, is so condensed by compression, and so affinitively energetic as to be susceptible of infinitely modified measures of pulsatory excitation, induced by those more generally prevalent and delicately acute. The effects of this form of undulous excitation is what is usually designated heat; with respect to its character, cause of action, and source, various and insufficient views are entertained, conducting to no satisfactory solution of the problem we have so decidedly the means to solve.

We do know that our sensible atmosphere is the medium in which sound is propagated, the pulsations being caused in this substance by a succession of radiations (from the sounding bodies) of spherical compressions and relaxations of the affinitive elasticity of this aerial medium, which are usually understood to be a succession of undulous wavelets.

If by this pulsatory excitation of our common atmosphere all the sound-giving excitements induced by distant objects are imparted to the organs of sense, we see no reason why a suitably conditioned substance associated therewith may not, by vibratory action, be equally the medium of communication between the light and heat exciting substances and the senses affected thereby; for in nature all things are analogical, being affected by the same simple rules. And as there can be no excitements but in substances, those of heat, light, and electricity must have a medium of action. There must unquestionably be an intermediate medium as well qualified for the propagation of light and heat between the exciting substances and the sense of them, as for that of sound by the intermedium of the atmosphere.

The effects of light, heat, electricity, magnetism, and even sound, upon sensible substances, are not to be regarded as the consequences of any rapid transference or projectile motion of a fluid substance, but of some modification of excited action in the substance itself, and of which it is susceptible, for when in quiescence there is nothing by which its presence could be manifested, hence it is not at all essential to the existence of such an all-prevalent substance that it should in itself be a sensible one. Men were familiar with the sense of sound long before they knew the manner or medium by which it was communicated. Sound is now known to be a readily excitable and rapidly extinguishable pulsatory action of our sensible atmosphere; and it is quite time it should be known that heat is likewise a readily excitable and somewhat less rapidly extinguishable pulsatory action of our insensible atmosphere, but tending constantly to quiescence; and this quiescence of calorific action is what becomes of heat when it is said to be radiated into space, or to be latent in substances, whose particular conditions it has resolved. The sustaining action of such substances is not made to depend upon the continuation of this calorific excitement, which is so readily extinguishable, but on the still more continuous, diffuse, and effective excitation of the medium immediately consequent from luminous action, and which is otherwise known as heat. There is no difficulty in perceiving a series of intimate relations as subsisting among the sense-exciting actions in general, and as generative of each other, particularly when they are known to be but the action of a medium common to all, and connecting the sensible with the insensible, in the relative order of their progressions.

We find a further illustration of this fact in frictional action, for every one must be aware that in this process of excitation, sound, heat, and light may all be elicited at pleasure from the same substances, simultaneously, and by the same means, and in almost all their gradations.

It is certainly well known that in sound-generating or propagating excitements there is no material medium emitted or projected from the sound-giving substance, as is usually supposed to be the case in the evolution of caloric, but that all is simply undulous action, imparted to the atmosphere by the vibrating excitements generated on the frictional surfaces, or induced in substances by concussion, causing an oscillation of their constituent molecules.

When we can thus have the sense of sight, sound, and heat generated simultaneously by the same substance, and by the same system of treatment, and an intermediate atmosphere being [illegible] impulsatory communication between the substance and the [illegible]e in the one case, why can we doubt of a similarly efficient substance being analogically effective in the other? Surely material action may excite the sense of sight, sound, and heat, and even the electric shock, while we remain perfectly unconscious of the existence or true character of the substance whose susceptibility for excited action causes all these kindred phenomena.

Were the atmosphere, by which the sense of sound is transmitted, perfectly motionless, we should have no more a faculty for the appreciation of its presence than we now have for the insensible medium in which the other subtile actions are so effective. Sensible effects, as we have said, can only be caused by the activity of substances of some sort, whether in themselves sensible or insensible, and in continuous connection, for separated substances could not be effective on each other. Visible substances, therefore, however remote, must be in connection with each other, through the intermedium of invisible ones, and these intermediate substances must be highly susceptible of receiving and communicating from one to the other such active excitations as are transferable.

This susceptibility of a fluid for such effectively minute alternating wavelets of vibration of its affinitive quiescence as could excite the effects and sensations of heat in all its gradations of intensity, can only be consequent from the high degree of tension to which the substance is subject, together with the force and freedom of effect of the energy of its own constituent molecules; and this excessive tension could be affected in no other manner than by the compression caused by its depth. The susceptibility of matter occupying interstellar space for instant oscillation of its atomic pencils between body and body, however great the interval between them, can only be attributable to its total deprivation of all energy, in place of being that energetic and highly tense substance in and by which alone (as we have but now seen) the undulous pulsation of high character could be propagated. We can not for one moment imagine that the delicate pulsations of light could overcome and operate on the affinitive tension of such a substance over an extent so vast as that by which many of the stellar bodies are separated from each other, the very circumstance of the undulous vibration of a material substance so necessarily implying its elastic tension. We should suppose this in itself sufficient for a philosophic mind to condemn the idea of the transmission of luminous excitation over such vast intervals by undulous action, even if such action were otherwise of such a character as could cause the phenomena of vision in all its prevalent precision.

We have seen that even in this our earth's invisible envelope, where the tension is sufficient to make the undulatory excitement of heat and electric pulsation so readily propagable and prevalent, the propagation of luminous pulsations through its depths would be impossible, only as atomic pencils oscillating intermediate of its constituent forms.

How, then, could any substance so intensified as to be susceptible of undulous pulsation so acute, propagate them onward through depths so vast as those between stellar bodies, and that, too (as it would be), in total disrespect of the affinitive effectivity by which such substances could be made so tense?

Without a material connection we could have no intelligence of bodies so remote; but how could we have that connection unless the intervening atoms were in contact? for were that materiality disconnected or incomplete, but by the extent of one atomic space, the effect would be as entirely cut off as though the whole intermediate interval had been a total blank. With a material connection even thus perfectly continuous, and this materiality endowed with the properties that are usually assumed to be essential to matter, it would be equally incapable of telegraphing tidings from such infinitely distant objects as if it had not intervened at all. Hence we perceive that there is in nature but one form of effectivity by which luminous action in the matter of one body can beget luminous activity in the matter of other bodies, and that is by the instant oscillation between body and body of the whole intermediate column of atomic pencils throughout its whole extent.

The affinitive elasticity of the exterior surfaces of these telegraphing bodies being constantly impressed with luminous excitation, caused by the motions of their own encircling planets, are as continually reciprocating this action, not only with these encircling bodies only which induce it, but likewise with each other, in every manner of creation. Thus all is put in immediate action and never-ending connection with all, in the interminable continuation of [illegible] existence.

This oscillation of atomic pencils being the only form of activity that can be continuous between body and body through all distance, and this action originating in a source of unceasing perpetuation, must be productive (in the substances thus connected) of every species of activity that takes place among their constituent matter.

We have already contemplated how it affects undulous vibrations in the affinitive medium between whose constituent sphericities these oscillating pulsations of light are propagated, they being the originators of all the other activities in matter; there must be an intimate relation between the sense-exciting substances of nature and the intermediate medium by which they are represented, and this relation we conceive to be readily traceable, for we find in certain conditions of substances their relations to be such that sound, heat and light may be all elicited through a very considerable range of intensity by the same means, and we may observe what conditions of the one are most readily productive of the other. These sense-exciting substances not being in immediate contact with our sensitive [illegible] indicate a medium through which such pulsatory [illegible] can be made, and whatever the precise character of [illegible] pulsations, this medium must be analogically [illegible]

When [illegible] substances are subjected to pressure of contact, and [illegible] over each other, they will so vibrate each other [illegible] pulsations that excite the sensations of [illegible] light; and it is readily perceivable that these [illegible] excitements are in the grade of pulsation induced [illegible], and not in any difference in the medium [illegible] may be of every grade and character, but the [illegible] must be for all the same; and in some substances we find the [illegible] excitement to be so acute as even to [illegible], and still in the same medium that vibrates the other excitements, however different the electric action may be in its effects from any other, there is no need to assume for it any other source or medium of effectivity. We should suppose it altogether conclusive of this common medium of excitability simply to remark, that as no unassociated substances having different characters could occupy the same space, therefore, if the sense-exciting mediums were different, we should never find heat, light, and electricity associated; hence this association of these phenomena certainly proves that the excitable medium of transmission is the same for all. When we are so well convinced that it is by the elastic vibrations of the surface molecules of frictional substances, caused by a succession of acute oscillatory displacements of the affinitive forms constituting these substances, that the pulsations of sound are imparted to the atmosphere, why should we not infer that the heat and light excitations evolved at the same time, and so immediately in association, should not be imparted by the same elastic vibrations of these surfaces to a medium with which our sensible atmosphere is associated, and though insensible to us, yet intermediate, contiguous, and excitable by such oscillatory action as that which excites the sound-inducing pulsations? In the massive substances and high-motioned journals of machinery every one is aware that if friction is not prevented by lubricating substances, sound, heat, and light may all be induced to a very high degree; and although the circumstances are here somewhat different than in sound-inducing substances in general, the exciting processes are precisely analogous, for in any case such are equally caused by an infinity of alternating condensations and relaxations of the affinitive action of the molecules forming the mass; and in frictional substances surface molecules more particularly are made to oscillate over their own spheres of affinitive relation or points of affinitive place; and if these oscillations (not undulations) can cause the undulous pulsations of sound in the common atmosphere, and at the same time the undulous pulsations of heat in the more general medium of excitation, we can not perceive (when they become sufficiently acute by condensation) why they could not excite the oscillatory pencils sufficient to cause light in this same heat-exciting medium; for in all this we see but the most intimate association and relation in these several sense-exciting vibrations, although there may not be at all times any other sense-exciting pulsations induced in association with sound-giving vibrations in general, and of which we may name that of musical instruments in particular, that excite neither sensible heat or light.

All vibrating action being alike caused by the oscillative displacements of the constituent forms of vibrating substances from their relative positions, with their constant effort at restoration to repose, hence the particular character of the excitements will depend much upon these elastic susceptibilities of the exciting substances; for by the disturbance of tension and molecular affinity, whether that be in sensible substances or in the intermediate medium, we have all the active effectivities of nature.

Finding this disturbed tension to be the only cause of vibratory excitement or action of any sort, in a sensible substance, it can only be communicable by imparting these vibratory pulsations to an insensible substance intermediate, whose affinitive tension is responsive to their range of action, and which occupies such intermediate spaces as are usually looked upon as vacuity. Sound-inducing pulsations, even of the most acute character, are of a low grade compared with those exciting heat and light, or with electric or magnetic vibrations; and for these sound-propagating pulsations to induce these others, it is essential that the insensible medium of general prevalence and excitability should be affinitively associated with the sensible ingredients of our atmosphere, for in this compound association only could such pulsations be propagated by those that induce sound.

The reason why sound-inducing excitements are not in general generative of, or associated with, those of the other sense-inducing vibrations is, because these others are not usually accumulative, but diffused in the atmosphere or other substances as soon as formed; and why the frictional vibration of massive substances is an exception to this general rule is, because they are not all so diffusively imparted as soon as induced, but penetrate in a great measure, and condense in the all-pervasive medium of excitability by which the interstices of frictional substances are occupied. By a continuation of the frictional process, therefore, this condensation of vibratory action becomes progressively so acute as first to induce sounds, then heat in low degree, progressively increasing to the highest intensity, accompanied by light, because the calorific rays become sufficiently acute to induce oscillations of luminous character in the medium intermediate of the frictional bodies and the eye.

It is now, as we have already noticed, well known that the relative rate of all the sound-inducing vibrations are, by certain measures of pulsatory propagation in the common atmosphere, caused by first inducing a disturbance of the affinitive tension of more solid substances, from whose internal structure this atmosphere is excluded; therefore the vibration of the sounding substances must be transferable to this transferring medium or atmosphere from their surfaces; but such is not the case with the light and heat exciting mediums when not associated with the sensible atmosphere, for in and through every substance where the common atmosphere is excluded, it has free and immediate access; therefore although the frictional vibrations of massive substances are immediately no more than the measure of sound-exciting pulsations, which are too obtuse for light or heat, yet these being propagated internally, as well as externally, from the frictional surfaces, are accumulated in this common medium, pervasive of all bodies, which, when not associated with the sensible atmosphere, is a very susceptible recipient of these pulsations, but externally being associated with the atmosphere, it is a less ready recipient and propagator. The pulsations, therefore, accumulate in the mass until they become acute enough to cause the sensations of heat and light, even at times to a high degree.

Thus we perceive that the vibrations exciting the sense of sound, heat, electricity, and light, may all be elicited from the same substance and by the same means, and propagated in the same or associate medium; for although the pulsations generating sound are insufficient for the direct production of the others, still by their rapid accumulation and condensation they become equal to either.

Now that we have demonstrated the nature and intimate relation of all these excitements, with their effective conduct and character, and the precise nature and efficiency of the intermediate and all-pervasive medium in which they are propagated. we must perceive that the prevalent idea of a material emanation from the exciting substances, as a radiation of something substantive, is not only very erroneous, but even preposterous in the extreme. Physicists are always talking of the radiation of calorific fluid into space, and of the rapid transmission of the electric fluid from place to place by means of good conducting mediums. While altogether opposed to this, we find frictional substances evolving heat and electricity indefinitely, and without any diminution of bulk by the deprivation of a single atom; except such as may be rubbed off by friction, there is nothing goes out into space in such cases but the pulsatory propagations diffusing themselves in the medium in which they are induced.

The massive journals of machinery in constant motion may evolve sensible heat for years without the slightest diminution of bulk; on the contrary, with a positive increase or sensible swelling every time they give out a greater quantity than usual. It would be absurd to suppose a material substance could enlarge itself by a dissipation of its own matter. enlargements being by additions, not subtractions.

Why substances enlarge themselves on increase of temperature, is simply because the additional calorific excitement among their forms enables these constituent molecules to add to their circumferences the more lightly affected matter of which their more quiescent compressions had deprived them.

Whatever philosophers or physicists may say or suppose to the contrary, a material substance must be a material substance, and can only be sensibly enlarged or decreased by additions or subtractions of its affinitively constituted matter in contact, for there are no expansions or contractions to an ultimate atom, or to an infinity of such in aggregates, for, however constructed, there is no other substance by which they can be separated or made to take open order. Whatever may be the formative character or affinitive constitution of substances, matter must in all cases be equal to bulk, either in its sensible or insensible quantities, and in their intimate and associate relations.

The idea so usually entertained of repulsive forces intervening among material atoms, and ruling these relations in the erection of substances into open or close order, as their condensations, expansions, or other conditions would seem to signify, is, certainly, to say the least of it, the most erroneous idea that can be entertained.

We know the conditional quantities of substances are various, those seeming the most solid are only so because containing the most sensible matter; but even in them physicists find but a skeleton framework of so little real substance or solidity, that some have gone so far as to imagine that were even the whole matter of the earth without pores, and perfectly solid, it would be no larger than an orange; the inference therefore is, that all substances are so constructed as to require but a very inconsiderable amount of matter with much intervening vacuity, as if Infinite Wisdom had been under the necessity of making the most of small means, and constructing substances out of something and nothing, and the last infinitely the most prevalent—a strange compound we should say. Although we do admit that Power to be the most perfect economist, we can not perceive wherein would be the economy or consistency in accomplishing the scheme of creation by a relatively restricted quantity of matter to the infinite extension and complexity of means that can not be conceived of, but that are so usually assumed to be essential in fabricating the infinity of permanent and fluctuating phenomena, constructed from such a restricted supply of the substantive materiality by which alone they could be rendered recognizable.

We can well conceive of Infinite Wisdom effecting his purposes with the least possible means, but we can not conceive of complexity in first principles. Nor without complexity, or even with, how the phenomena of nature could have been evolved with matter occupying any limited portion of space, much less restricted to that quantity which physicists and our physical senses would have it to be. Nor can we conceive of primary complications of kinds, qualities, and conditions, without the contemplation of their determining ultimate and utter confusion. Nor is the unity of nature at all reconcilable with the severality of such primary conditions. Nor would the severality of such primary conditions be at all reconcilable with the unity of the Great Originator.

How, we would ask, could this Omnipresent Unity have originated this primary complexity with characteristics that could not be of him? or if they did not originate in this First Cause of all things, from whence could they have derived their being? If they exist otherwise than in man's imagination, they must have had an origin; if they exist, and had no origin, they must be attributes of the Eternal One, which we have already demonstrated to be an impossibility, for he is the perfection of unity, while they by their contrarieties are the essence of severality. They could not have been originated by physics, or they could not be the originators of physics; therefore it becomes evident of forces usually attributed to matter, that they could have had no physical being.

But how fares it with that matter itself? had it that primary plurality of condition which physicists usually assume when they tell of the different kinds of ultimate materiality? There is certainly no possibility by which we can conceive of kinds to this simple substantive existence but as conditional attributes; such conditions being induced realities, they could have had no ultimate or abstract existence, the rule of their order and relation being *à priori* of themselves. It becomes perfectly clear that there could have been no different kinds to the first principles of things. Nor will it be any more possible to conceive of this materiality as a limited quantity; for it being the only medium by which sensible expression could have been given to physical conception, it must have been at the command of the physical Originator, and he being omnipresent, could have commanded it from no remote quarter, therefore being thus involved in him as one of his attributes, it could not exist as a partial production. Now, can there be any principles in nature more demonstrably true than all this? Will physicists contemplate their force, and still adhere to the doctrinal dogmas of the day? All that can by any possibility be made of ultimate matter in its relation to ultimate thought, is that it was but an atom infinitely multiplied. All that can be made of the ultimate force attaching to these ultimate numbers is, that it was a unity in kind, but a severality in degree, and as every phenomenon in nature has been reconciled by this rule, every problem in nature must be solved by the same means.

Every phenomenal fact in physics, all forms, conditions, and relations in substances, are readily reconcilable with the affinitive combinations caused by this energetic gradation of this affinitive force, and we have certainly, this far at least, traced its effect very satisfactorily; and when following out this effective relation in substances whose temperature is elevated by friction, we have found by what process the lightly-effected enveloping matter is excited into action by the oscillation of the sensible and frictional molecules. Though this all-pervasive medium is not recognizable by any of our senses, it is, nevertheless, as much affinitively constituted of molecular forms as any sensible substance whatever, and must have, more or less, an affection for the substances with which it is most immediately associated, and the affinity for the constituent forms of sensible substances makes them participate to some certain extent in its excitement, and surround themselves with its molecules in the enlargement of their general mass, as their points of cohesion are agitated apart; and as the sensible atmosphere is excited into action by the vibration of musical instruments, so this insensible atmosphere is excited into action by the vibrations of the sensible constituents and excitable medium in the frictional substance. These constituents of such substances being thus excited throughout their whole internal structure, serve in some degree to counteract the effect of their cohesive impact, and hence more matter may be affinitively added to the constituent molecules, by which the general bulk becomes sensibly increased. These frictional excitements being the principle or only mechanical process by which sound, heat, electricity and light may be evolved from the same substances, and by the same means, are here most conveniently contemplated in proof of their intimate relation, and the existence, nature, and identity of the medium in which they are propagatable.

This analysis of the effect of frictional action upon sensible substances certainly affords a fair insight into the nature and analogical relations subsisting among the most important and effective subtilties in the operations of nature. We here observe the process by which these effectivities generate each other, all being reflected by planetary motion in that ever-present materiality by which all sensible matter is connected. Were the existence of this fluid in and about all sensible matter, together with the intense pressure of impact to which it is subject, any longer problematical, we certainly have its full confirmation in the electric current, for metallic substances are found by the sensible exhibition of its effects to contain this electric matter in one uninterrupted continuation throughout their whole extent, however prolonged that may be, so that it returns again into itself, or is connected by any suitable conductor in a circuit, as in the telegraphing wires now spreading their fibrous network over the land, transmitting the excitement of matter and mind almost as freely as that of light.

Mechanical action being much too cumbrous and inconvenient a process for the propagation of this species of excitement, recourse is had to chemical action, caused by decomposition and recomposition of molecular substances, whose affinitive action is induced by contiguity of metallic plates and acidified substances.

We have already seen that this intervening medium is so highly susceptible of electric pulsation as to be at all times charged with it, being constantly agitated into action by the oscillatory pencils of light; but this general action is too diffuse and equalized to be recognized as electricity only in its accumulated and condensed passage from one situation to another, as exhibited in the lightning's flash. Without a recognition of this all-pervasive medium, we are unable to perceive the process by which light, heat, electricity, and magnetism are evolved, and why they become sensible and practically effective at all. In either case the effect is consequent from the conducting power of the substances, and, as we have already seen, the *condensed* aqueous vapor in the atmosphere is a much more ready conductor than the same atmosphere when in a rarefied state; and this aqueous matter becomes the transmitting medium through which surcharged excitements, in certain portions of the atmosphere, distribute themselves into other portions less electrically excited.

This is because the electric medium is always so affinitively associated with the sensible atmosphere that the electric pulsations are less readily propagated than in aqueous substances, from which the constituents of this association are excluded, as is the case with metallic substances and other good conductors.

We see this in the transmission of excitement by telegraphic wires, the texture of these substances being such as to render them the most ready receptacles of this fluid, unassociated with any other aeriform substance of sensible qualities; so that any circuit of wire or other such suitable conductor, however prolonged, if returned again to itself, is found to be a ready transmitter of electric excitation, but not by propagating the electric impulsions with such rapidity along the medium contained in the wire, but in so many forward impulsions of the whole column of the electric fluid; that not being affinitively bound to the metal, or to any other substance, must have perfect freedom of motion.

The practical application of such impulsatory action being in a given positive direction from the poles of a battery, the whole fluid contained in this continuous circuit is made to feel the impulsions through its whole length, as so many projections or pushings forward of the whole continuous circuit. This is the process in telegraphing dispatches, and the reason why it can not be continued when the circle is incomplete or imperfect is, because the force of these impulsions is insufficient to urge the electric fluid forward over the interval, or the place where it is in affinitive association with the isolating atmosphere; and in such a case the general pressure (by which this electric fluid is rendered so excitably tense) would be so equable as to oppose the forward motion of any pencil of its particles not in continuous connection; for if all were equal and impenetrable, there could be no place of less impact into which they could flow.

Undulous pulsations in diffuse radiation are more or less propagatable in this medium, whatever may be its affinitive connection with other matter; but the displacement of the substance itself is an absolute impossibility, unless in a continuous circle, and in infinitely short projections, as in the conducting wire; for the constituent equability of this substance itself, and the perfect uniformity of the pressure to which it is subject, renders it all so perfectly alike that nothing can induce a change of place nor a place to which it could be urged, unless when in affinitive relation with other matter, such as the atmosphere, etc., they all being in affinitive solution with this electric ocean; it would, in this associate manner, and no other, be subject to displacement, progressive motion being otherwise an impossibility, save, as we have said, round, or rather, we should say, forward in a continuous circuit.

This form of circuitous excitement being the only exception to the general diffusibility of electric pulsations propagated in this medium, is induced by special and particular circumstances, favorable for such form of action; for the impulsions in such case are propagated in a given direction, instead of being, as is usual, diffusely radiant from the source of excitation. When an unobstructed circuit (by the intermedium of the metallic wire) is formed of the electric fluid in its unassociated condition, it is thereby the most susceptible of excitement, and however intensely compressed, the slightest impulsatory force will necessarily induce in it undulous excitations; and those being propagatable only in one direction, every condensed impulsion forward in this direction during the excitement leaves its equivalent relaxation behind, thus giving to one end of this continuous circuit of fluid molecules an opportunity of as many impulsatory advances on the other's forward motion, there being in reality no separation or detachment of the fluid column at the point acted upon, but simply a series of forward impulsatory excitations of the whole pencil of electric molecules. Were not the electric ocean under intense and equable compression, it could not pulsate the acute electric excitement at all, more particularly these forward motions of the whole fluid column; for were the medium more lax, the exciting force would make it penetrate itself (if we may so speak), so that the compressive impulsions would become less and less distinct, to their total extinguishment in a short time.

The fact that these circuitous excitements suffer but little if any diminution in this respect, is conclusive of the high state of compressive tension to which this substance is subject, and being under this same impact in the wire, as well as in every other substance in or on the earth, the same equal parallel must give the same equal pressure anywhere in or round the world, otherwise electric excitement would not thus act round a continuous circuit, but would be speedily dissipated, or find its way into that space which presented the least resistance.

Finding this substance so connectedly occupying a metallic wire throughout the greatest possible lengths and the finest threads, we must conclude the molecular texture of such wire to be favorable for the isolation of this substance from affinitive association with any gaseous matter whose effects would disqualify it for the propagation of telegraphic excitement.

It will now be perceived that more especial activity of this vast ocean in the production of excitements, although in itself of an identical character, is productive of very dissimilar phenomena. We have, in its general diffusion by the continual but unequal action of the sun, its constant and steady expression in the pulsation of the magnetic needle; but in this general magnetic action no light is elicited, except in its occasional accumulation at the poles, causing the northern or polar light.

We have, in its condensed transit from one stratum of atmosphere to another, its sensible expression in the most vivid lightning, and at times in other sensible indications. We have its chemical and sensible evolutions in a circuit, not only as an expression of this mode of action, but as the transmitter of man's thoughts in perfect obedience to his will. But in this gentle and manageable exhibition of its energy no luminous excitement is induced.

We have likewise frictional electrictity (of which the Leyden jar is a well-known example), readily imparting shocks and giving out luminous sparks. All these different exhibitions of energy are induced by, and are the effect of, pulsatory excitement in this all-pervasive substance, which in a quiescent state could effect nothing. And although the sensible effects are so dissimilar, the characteristics of the inducements are identical, for only one species of activity can be propagated in it, and this is by a pulsatory disturbance of its elastic tension or quiescent state, and its compressive effort constantly causing an equable distribution of such disturbing action, and a final restoration to rest. This disturbing action, as a general principle, takes effect in the form of miniature compressions and relaxations of elastic force, these distributing themselves in a progression of undulous wavelets. Now this is not very likely to cause the electric effect along a continuous wire, or other conductor, in a particular direction, for no vibratory pulsations can possibly flow out from their source of excitement with such rapidity of motion and such acuteness of action to such distance, and return again to that source, as the telegraphic action along the wire is found to do.

We find in every other instance fluid susceptibilities are such as will receive pulsatory impressions of the most acute character, without returning upon the place where they are propagated. And we can not see how the fluid pervading the wire should be such an exception to the general rule.

Surely pulsations might be propagated in this fluid at least equally well when in a conducting substance as in any other, and there can be no question but that they are so propagated, and these conductors permitting their impulsatory pulsations in but one direction, as induced by the chemical action of the metallic plates and acids. This being the case, and the conducting circuit complete, the compressive propulsions excited into action by the molecular activity of the acids and metals in effecting an affinitive transformation of these substances must be in that direction, and when so, and the circuit unbroken, in place of them propagating themselves in the usual way in the fluid in general diffusion; the whole column of fluid in the conductor is thereby induced forward with as many pulsative propulsions, so that in place of these excitements being impulsatory propagations in the fluid, they are pulsatory propulsions of the fluid itself round the unresisting circuit. This is because of this fluid being so compressively tense as to be with difficulty further compressible, so that pulsatory excitements induced in any part of this circuitous continuity causes the circuitous motion of this unobstructed fluid more readily than its agitation into undulous excitement. Analogous to this would be a circuitous tube perfectly full of water, which is likewise a substance considered almost incompressible, suppose in this aqueous circuit a metallic disk of the size of the tube were inserted, any propulsion of this plate would immediately affect the forward motion of the whole fluid column, and were any impulsatory action induced on this dividing disk, such would equally affect the whole contents of the tube. But this aqueous and positively inert substance is in this case but a poor representative of the electric medium when occupying a conductor with its infinitely excitable susceptibilities.

The light-inducing pencils oscillating between body and body, which we have already considered, much better represents this motion of the electric fluid with but this difference, that the luminous pencils are oscillatory propagations from body to body, while these electric propulsions are continuous in one circuitous direction; when this connection is broken by but a slight interval, and the exciting cause still continued, the vibratory pulsations are induced in the fluid itself, until it may become so overcharged with this excitement as to burst through the interval occupied by the disconnecting medium, in which case it often sensibly manifests itself by exciting the oscillation of light-inducing pencils and the exhibition of sparks; but when the circuitous connection and excitement are both continued, the propulsions force round the electric fluid contained in the conductor, and produce a minutely intermitting forward motion of the fluid itself; the reciprocating waves of laxity being least resistant, afford a corresponding series of partial incompressions into which the waves of greater tension thus formed must fall, consequently causing intermitting forward motions of the fluid itself. We find that without this circuitous connection of this fluid in a medium for which it has no affinity, chemical action can not go on with the same freedom among the acids and metallic plates of a battery, because the chemical affinities have not in themselves force sufficient to overcome the usual pressure that surrounds them, and therefore can not act, because a revolution among constituent molecules of existing conditions requires more room than they can make for themselves, while so much pressure is acting on them from every quarter. But the force which could not generate vibratory action under such surrounding pressure, might be sufficient to produce intermittent motion in an unresisting medium. Analogous to this is the well-known fact that steam is formed under a much less temperature when relieved from atmospheric pressure, and that it is only formed at all by being in a measure relieved from general pressure by calorific excitation. While chemical action between acids and metallic plates is only productive of this delicate and manageable form of electric effect, so long as there is a connection between the poles of the battery and a constant agitation or action of the connecting fluid thereby kept up, we find electricity can be generated in condensed quantities, and retained for some time in the exciting locality when the circuit is not complete; this is because the electric fluid is so associated in molecular affinity with the surrounding atmosphere as very much to impair its excitability, or, rather, its transfusibility, and is consequently a less ready recipient or propagator of pulsatory action; this action, therefore, crowds itself in a condensed form where the elastic fluid is least affinitively attached to other matter with which it is associated; and however much condensed in this manner, it is seldom appreciable. But the instant a circuit is formed with a proper substance, it is felt and extinguished; in other words, the equability of pressure and excitement is restored by the unassociated fluid flowing forward and closing up the alternating depressions of pressure; so there is no longer any appreciable action. This vibratory rush forward upon a partial disconnection where atmosphere intervenes will elicit sparks, because it is there partially obstructed and condensed. Shocks, likewise, are the effect of high and extensive condensation, when acting upon an imperfectly conducting substance, the reasons of which we will notice hereafter.

We have noticed the general processes of electric action, but as the fluid is prevalent in every thing and associated in multifarious forms, the modifications of its action, even when they manifest themselves to the senses, can not be strictly calculated in all their relations. And so susceptible of delicate action is this electric medium in some of its associations, that we are very much disposed to infer that the human mind is indebted to its agency in the invasion of the nervous tissue for its susceptibility in receiving and transmitting impressions.

The outward impressions being induced by outward vibratory action we can easily understand, and its responsive effect upon the electric fluid in the nervous tissue. But its internal excitement by volition of the will may not be so readily comprehended, although the analogous effect confirms the fact of their identity; and in reality there is but little more difficulty in conceiving how the mind can affect the fluid into vibratory action, than there is in conceiving how vibratory action should affect the mind. However this may be, it must be here observed, that although the mind can make this fluid its physical agent in the organized mechanism with which it is associated, the fluid being in itself a material substance is no more the intelligent principle than is the foot, or any other member of the organized machine. So modified, indeed, are the excitements in this all-pervading fluid, that they can equally rend a mountain or move a muscle by the volition of mind, and still the substance is in itself so obscure as hardly to have excited a suspicion of its prevalence or character. So modified are even its sensible excitements, that they pass through all the heat-generating pulsations into every species of electric or magnetic exhibition, the same susceptible and unseen fluid being the grand source of all such phenomena, and which well accounts for their associate relations. To ascertain the relation between the excitation which produces heat and that which evolves electricity, and even light, we have but to consult frictional analysis; we shall there find in some instances that the same substances and the same frictional action will elicit both orders of phenomena. Sensible electrics, as amber, glass, etc., will evolve heat and electricity at the same time, because this fluid is so infinitely susceptible of responding to every modification of excited action.

These substances are electrics, because their structural economy and molecular affinities are such that friction effects a more minute displacement of their particles relatively than in other bodies. These reciprocatory displacements, by the passing of one surface over another while under pressure, impart to the propagating fluid resident in them that order of excitement which becomes sensible electricity, while substances in general whose structural affinities admit of more lengthened displacements under frictional action evolve heat more freely, because the vibrations are much more obtuse, to which modified condition of excitement the fluid responds, producing heat. And in an affinitive association with our atmosphere we find it sensibly responsive to the calorific order of pulsations more particularly, and not so much to the more delicate electrical action. This excitable fluid, resident in frictional substances, is often at first only agitated into pulsations which are productive of sound; but not parting with them so fast as they are generated, they condense and accumulate upon each other in the frictional substance, until they are sufficient to excite heat, and even light; and there being a mutual participation of this order of action between our sensible atmosphere and this insensible substance, heat may be induced for any continuous length of time, even with considerable intensity, without any special emission of materiality from the heated substance whatever.

These sensible and insensible atmospheres and invasive fluid are so mutually reciprocal of each other's action, that no diminution of temperature will be perceptible in any substance by exhausting it of its sensible atmosphere. And as respects the insensible and invasive atmosphere, it being the only power by which structural formations are affected, and their conditions sustained, there is no power by which any substance or any place can be exhausted of this matter. Temperature, therefore, is but the sensible expression of the activity of the insensible matter resident in substances from which the common atmosphere may be excluded, and must be more or less communicable by affinitive relations with other substances, and which may be supposed to have different effects upon different substances. The affinity of this fluid for some substances is so light as to be so abrogated by contiguity with electric currents, as that the fluid in a piece of soft iron is made to act magnetically. Now, in this case, we perceive it requires but little force to disturb the usual affinity of these substances, a good proof of how little the fluid in the wire has to prevent its electric propulsions in telegraphing. This magnetic action induced in the iron will continue for a considerable time on its own account before the affinity of the iron for the resident fluid will overcome its action.

By and through this all-prevalent, highly compressed, and excitable fluid, it will now be evident that we have heat, light, and electricity resident and abiding in every form and substance, sensible and insensible; let but the conditions be favorable for the order of excitements peculiar to either, and it will be instantly and irresistibly evolved. Now what shall we say after contemplating this beautiful and simple economy of nature, and contrasting it with those hypothetical systems and notions that usually prevail on this subject, with their far-fetched ideas of emissions, transmissions, and radiations into space, and receptions from the sun and stars of some sort of calorific substance, of which our earth is supposed to be losing so much as to have been refrigerating down from incandescence into a temperature to which no one can guess how low it may yet descend. This and the electro and magnetic currents assumed to be traversing space and planetary masses, with all the measures of velocity attributed thereto, and all this under some peculiar, mysterious, and unexplained system of dynamical law, of which the sun is assumed to be the grand source and battery for originating and projecting these fluids, which are so transferable, with all their negative, positive, and polarizing peculiarities, all this is certainly so evidently absurd as not to serve for one moment against these truthful processes of nature that we are now attempting to teach. Surely these deductive, systematic, incontrovertible, and inevitable facts, that present themselves in the order we have been contemplating, will contrast so favorably with the inconsistent, inconclusive, conflicting speculations hitherto adopted, as to attain for this system a triumphant decision in its favor.

Chapter Seven.

Chemical Nature—Change from Fluid to Solid—Crystals—Expansion of Sensible Bodies—Atmosphere—Calorific Excitement—Absurdity of Repulsion—Combustion—Unity of Law.

Now having traced the creative process thus far, we will see how it will develop itself in the great laboratory of chemical nature, and in the production of the various forms, kinds, and characters which are usually considered to be chemical elements, and the origin or root of things. All the conditions of matter subject to physical inspection or analytical scrutiny are to be (as we have more than once shown) regarded as but some of the expressive terms of a great series of forms upward and onward from what are really the essence of things to the aggregations of solar systems. The formative affinities being everywhere alike, differing only in degree, and the matter on which they were acting being alike without degree, it could not have been that there were any variety in the structural economy of ultimate forms or their configuration, for such would imply progress in physics. The ultimate molecules having most energy would in the order of things, as we have already seen, constitute themselves centers for a new series of associate forms, constituted of those in greater proximity to them, they being the nucleuses around which these other forms would arrange themselves spherically, and in strata decreasing in ponderosity outward from these several centers. This process of construction for first forms and compound forms must have continued and remained the same while matter was aggregating and retained its fluidity, from initial magnitudes to the concentration of solar and planetary masses, because what ruled the first must necessarily have determined the last, as nothing new could have been introduced further than could be effected by progressively aggregating combinations of matter and energy. Equal energy at equal distances from common centers must have been the rule for the disposition of matter in all substances, whether as initial forms or solar fabrics; and if there are now exceptions to this rule as respects the disposition of matter round planetary masses, there are no exceptions to its constant effort to reduce itself to this rule, as is evident in the conduct of the water of the ocean when disturbed by any cause. The exceptions to the rule are only in seeming, the disobedience being caused by some other induced force opposing this general effort.

The most formidable of all, and indeed the fundamental source of all obstacle to this general effect is what it imposes on itself by the intensity of its own pressure, caused by this very effort at equalization round a common center. Having found this pressure to be the cause of most of the sensible phenomena of nature, so far as we have examined them, we shall continue to hold it responsible in a great measure for all that are to follow, for we shall find without its instrumentality the other operations of nature would have been a waste of energy. This pressure is inevitably consequent from aggregated accumulations and combined energy of the mass being directed, as it were, to a focal point situated in the center of the whole. This direction of aggregated energy would impose pressure in proportion to the energy of the incumbent mass, not as the quantity of matter composing the mass, for, as we before stated, there must be equal quantity for equal bulk, but it may be otherwise with the energy resident therein.

It may not be improper again to observe here that this compressive energy would necessarily dispose the matter to which it is especially attached in strata of equal grade round this same focus (particularly in absence of any abstracting cause) at precisely the same distances, the thickness of the stratum depending on the quantity of forms at equal gravitating grades by having equal and associating affinity; and this would remain so long as the molecules were spherical globules of fluid construction. But, as observation proves, this is not their present condition: we must direct our inquiries to what has brought about this great change from fluid to solid substance. And, in so doing, we shall at once perceive there would have been much matter which could not have continued in the fluid condition in which its molecules were formed, because of this great pressure, particularly those of largely compound character; for those under great compression would be unable by their own constituent affinities to retain their spherical proportions or relations; for, as an inevitable consequence of the pressure of fluid spheres, their external stratums of most lightly affected matter would be forced into angular positions, or such as would on aggregations of solid sphericles be their interstitial vacuities. Another consequence of this pressure would be, that much of the most gravitating matter could not have been retained under this density of impact at all, but must have been ejected outward to where it could more affinitively assimilate and associate with that of its own grade. This pressure upon spherical forms, by displacing much of their exterior matter, and deranging their sphericity, would so much abrogate the affinitive equilibrium of their structural relations as that their nucleus forms of most energy would, by the force of their affinity for each other, relinquish their spherical adjustments round their sub-molecular centers, and again form themselves in affinitive relations with such centers in lines of greatest force and least resistance, thus forming crystalline needles connecting centers by points of contact. We must observe here, that in the fluid substances, particularly in early times, conditioned for this process, all parts would not be equally subject to simultaneous transformation of this sort, because of there being great variety in the size, force, and composition of the constituent molecular sphericities.

Therefore, at the commencement of solidification, those molecular forms in the fluid mass that were the most energetically affected, would so affinitively operate upon each other as to disturb their former fluid arrangements, and form them into lines or pencils agreeable to the most affinitive action, constituting thereby crystalline needles, radiating and ramifying by points of infinitesimal attachment, and leaving the less energetic forms with which they had been spherically associated to form new orders of social relation in the intermediate spaces. These, again, in their turn, would likewise become subject, in their most affected forms, to further solidification, so soon as pressure accumulated sufficient and quiescence prevailed. This process of solidification, by the construction of crystalline needles, would continue to progress while pressure continued to accumulate sufficient to reduce the less and less energetic molecules to this solid state, for all matter having energy sufficient to make it susceptible of solidity, under the existing pressure, would thereby be forced to constitute a part of the solidifying structure. The molecular forms of such a substance, in which energy and pressure were insufficient to reduce to the solid condition, would, by the composition of their affinitive and associate forces, compel the more energetic matter to project itself in an infinitely complicated tissue of crystalline network, attaching by infinitesimal points of contiguity, from between which the compressive fluid of which we so much speak would be excluded, and by its pressure externally to these points of contact it would make them cohere with that force of contiguity which characterizes solidity, and which is usually called the attraction of cohesion.

Now this fluid matter, insusceptible of solidification, intervening and surrounding all such forms as are disposed in crystalline needles, we may assume to exist in every substance (however solid it may seem), forming by far the largest quantity, and that which we recognize as porosity or vacuity; but it must be regarded, as in truth it is, a very important condition of matter, without which the sensible parts of substances could not be what they now are. For to this fluid and its intense pressure are we indebted for solidity in any form, fluidity being the primary or first condition of matter as the rule of its state, to which solidity is the exception, being a meager skeleton framework of solidity by outward compulsion, and not resident in the particles solidified, but altogether extraneous, and the result of the gravitating energy of every atom of a mass seeking to place itself on the common center of that mass, and would be otherwise than solid were it not for this constraint. Now as this occupancy of one center by all is an impossibility, the center-seeking force must make all operate as a pressure incumbent on all such matter as is inferior in position. We have seen that the sensible or solid portion of our globe must be in but a very small proportion to that which constitutes its invisible but most effective quantity, or entire bulk, in which we can be at no loss to perceive the pressure by which the solid or skeleton framework of sensible substances is secured and made sensible.

The recognized porosity of the most solid substances, and the pervadibility of this insensible matter being such as it really is, there can be no particles attaching in points or crystalline needles in any substance to which it will not apply in force of pressure proportional to the attaching surfaces, altogether superseding any necessity for cohesive attraction, special or particular. We have here a force consequent from the very nature and condition of things to which all orders of solidity may, without question, be attributed.

Cohesive attraction, as an attribute of matter, has always been a very unaccountable thing, but not so that cohesibility which is the effect of this all-pervading force. Cohesion being a condition of circumstances, very well accounts for any of its fluctuating effects, and the force which is its cause being, to some certain extent, affected by circumstances, will admit of all its modes of action without the polarizing and repelling forces so generally attributed to matter.

When any substance very solid or in forcible connection has been rent or fractured, physicists are confounded, because on readjustment of parts and application of pressure adhesive restoration could not be obtained; but this will be no longer a matter of surprise when we admit the prevalence of this subtile fluid with its intensity of pressure, for we shall then no longer expect to expel it by pressure from between what were the connecting points of the fractured surface. This circumstance alone is a strong evidence of the prevalence of this pervasive medium, and of pressure, and its being the effective agent both of the cohesion which holds the body together, and the repulsive force that prevents the reunion of their fractured parts.

All other forces which are usually regarded as chemical can only be considered as effective under this pressure; for to whatever extent their affinities are effective, it must be by virtue of the operation of this force. We see with what facility the cohesibility of matter is accomplished by this all-pervading pressure, and we likewise see the impossibility of cohesion taking effect on fractured surfaces, for points of contact can not be made to exclude this insinuating substance of such subtility that must intervene. A reconstruction of connecting molecules must be the only mode by which fractured surfaces can be again permanently united, and this must be under favorable circumstances, and by the formative effect of molecular affinity.

The nucleus matter of our globe being under vast compression would, as we perceive from the evident facts of the case, begin to solidify first, for by the denudation and expulsion of its least gravitating molecules by this pressure, it would become reduced to a semi-fluid or liquid condition, and this, by becoming further compressed, would be forced to a reconstruction of its own molecular associations, as exemplified in the crystalline disposition of nucleus molecules, as above noticed. Only a small portion, and that of the most energetic matter, could assume crystalline forms; much the greater part, therefore, would occupy the interstices among the solids, and these interstitial forms, on their rejection by their former central associates, would satisfy their affinities by the formation of new orders of molecular association among themselves, retaining still the full perfection of their fluidity. This process of solidification, in its most unmixed character, would evidently begin its operations at the earth's common center of gravity, from the greater amount of pressure there, and the greater energy of subjugated matter, likewise the expression or expulsion of unassimilating sorts. But this solidifying action would progress from thence outward, while there continued to be accessions of pressure sufficient or compressed matter susceptible of solidification under the pressure superimposed.

Now, with no other consideration but the simple effect of gravity and pressure, we find ourselves deducing a system of things which does not now prevail; for while we find, by this process, a certain amount of our earth's matter would be transformed from its fluid state into that of the solid, we must at the same time be fully satisfied that the surface termination of this solidity would be at precisely the same distance from the center of the great solidifying sphere; for by the rule of equal energy, at equal distance, for the disposition of matter in the construction of a sphere, equal solidity at equal distances would as certainly ensue. Observation proves this not to be the case, as we find at the earth's surface great inequality; but on further consideration we shall be fully satisfied that this does not disprove the general rule of spherical equality. Rather from this very fact of inequality of surface we infer that our globe could not have obtained its present magnitude by accession of matter in such states of fluidity as would have enabled gravity to effect its distribution agreeable to this general rule.

This departure from the effect gravity would have in the distribution of fluid matter would become more and more marked as the earth received contributions from space of matter constantly undergoing its own constituent transformations to solidity, and thereby becoming less and less manageable the longer it was left to continue this isolated action. The consequence of all this would be to cause a progressive accumulation (upon the solidifying surfaces) of molecular matter in every modification of its constituent characters. There would be accumulated such structural forms as were unassimilating with and expurged from both the solidifying and insterstitial matter of the earth's nucleus, together with that derived from coalescing substances. The great effect of all this would finally be, that on or near the earth's surface there would be accumulated every variety of molecular constituents that had not assimilated themselves with massive and solid formations, and thus were left to affiliate in chemical combinations with each other, exterior to this solidifying surface. We have evidence of this fact in the bowels of the earth; when we get down to those formations which were not exposed to atmospheric or aqueous action during solidification, we there find chemical products less plenty as structural conditions are more simple. We find this to be the case even at the surface of the primary granite, which constitutes the foundation on which rests the heterogeneous assemblage of mechanico-chemical stratifications of rock, many of whose constituents are not traceable to the granitic matter at all, but seem as if they must have obtained their matter subsequently, and from some other source. At least there are but few of the chemical constituents to be found in the granite rock of the present day, and our deductions determine their position to be near the terminating surface of solidification, where they would be more particularly available for the furtherance of organic action.

Philosophers inform us that the matter for the strata composing the earth's crust was derived from the degradation of granitic rocks, or purged out from the bowels of the earth; so agreeable to this, and being altogether unaware of any other way, it is not surprising that chemists, physicists, and philosophers of all kinds, should contemplate this as the only source of substances existing above the granite, and that chemical properties should be assumed to have such a derivation, by the action of forces, of which nothing is known, save their assumed adequacy to bring them forth and place them where they are, whether inclosed in rocks, resident in caverns, composing organic forms, or floating in the atmosphere.

Now to us this is perfectly incomprehensible, this rising of such masses of matter, in reversion of its own gravity, from the depths of the earth, and piling themselves up in such ponderable superstrata as now constitute the earth's crust. It is certainly a monstrous conception, equaled only by the kindred idea "that the abrasion of granite should go on below what would be to it a protecting coat of its own outspread matter, until it had heaped over itself the great depth of strata for which it is assumed to have furnished the material." Now, when such ideas can be entertained of the sources of superimposed matter, there can be nothing too absurd for credulity; hence the accounting for the various properties and conditions of matter indeducible from granite, by assigning them a source in that same miraculous reservoir of physical fecundity, situated somewhere far down in the depths of the earth, and sent up to its surface by forces of undefined and unknown character, about whose operations we are so often entertained.

The system we here present has at least the merit of simplicity, and we have developed it sufficiently far to find that chemical conditions and constituents of every known denomination, as well as all other things, must have originated in unity, and are therefore but secondary qualities of varied molecular formation; and so far as abstract matter is concerned, we can not see why it could not have been made to take either of the molecular forms that chemical affinity calls for; it being in itself perfectly passive, every condition subsequently assumed must be an induced condition, and every form a fabrication, hence the constituent molecules of every substance are each a fabricated combination of such preceding forms. Certain it is, the constituent matter of every sensible substance (whether considered elementary or otherwise) may have been the constituent matter of any other substance under different orders of affinitive and other circumstances, therefore susceptible of transmutation. Although we have determined that the energy imposed upon atoms can by no possibility be again abrogated, still the forms such atoms may have assumed can not be considered equally indestructible, much less their combinations; for on the same principle that atoms of unequal energy would form themselves into sphericles, these unequal sphericles could reconstruct themselves into other globular forms after the manner of the first, and the resultant substance would be as the circumstances of structural formation might determine; therefore we may safely assume that if substances are formatively subject in any manner to existing circumstances, their matter must be susceptible of metamorphosis on a change of such circumstances; and although art may have been unable to reduce many of them to more primary conditions, the energies of nature may not be equally inadequate, for with her we assume there are circumstances both of reduction and metamorphic reconstruction of any observed species of matter; for surely when the compound molecular constituents of substances can be sufficiently operated upon by disintegrating forces, the reduced molecules would be at liberty to reconstruct themselves in such other forms as conditions and circumstances might dispose, so that they may again present themselves in a very different condition. But as the same circumstances uniformly produce the same results, we see that however effectually art may decompose many of the substances, she can not so effectually or permanently change the order of affinitive forces; and when she does not, the same operative circumstances would certainly again produce the same structural formations as at first. But when nature produces such a reduction in her ordinary processes, it is because the circumstances have changed, and that she requires some of the molecular ingredients for the fabrication of some other species of matter then in process of production under this new order of circumstances, which species, like all the rest, must be in the regularly fabricated order of sphericles. The evident facility with which she can metamorphose some of her combinations should satisfy us of her general transmuting abilities, and more particularly in all such substances as are evident to the senses.

We certainly can not permit ourselves to imagine that mankind can have got hold of any of the matter in that particular condition of its materiality wherein it makes part of its Maker, or as it was with him in the very inception of physics as a coeternal attribute of his own character, and from which all sensible conditions must have originated. The interval is so vast between what can be physically apprehended of matter by the creature, and its primordial condition as an attribute of the Creator, as to preclude all possibility of any experimental inspection by man of its primordial character. But while this inconceivable interval unquestionably exists, there can in reality be no interval in the infinity of forms and conditions by which these two extremes are connected; and as a partial evidence of this fact, we have the microscopic organisms occupying intermediate positions in this seeming void.

Experimental chemists undertake with much confidence to tell what are the constituent properties of substances in general, but we question whether they can analyze the molecular fluids which flow in the veins of these monadical forms, or the components that cause their nervous susceptibilities. By microscopic powers of vision these have become sensible organic individualities, but of what are the molecular infinitesimals of which they are constructed? These miniature organs and fluids are surely as much erected by the rudimental forms of matter as those of the greatest magnitudes can be, for any congeries of atoms in the abstract would be altogether in-elastic, and so without the required tension by which life could be induced, sustained, or made effective. Chemical analysis can be available or valuable only so far as it enables us to discover what are the sensible constituents of sensible substances; but this process will never enable us to fathom the profundities of nature, so far as to find in recognizable substances the roots of things, or the first forms that matter would necessarily assume under the influence of imposed energy. We must regard sensible forms as entirely different from matter, unrestricted in the free exercise of its own attaching affinities, and under no pressure whatever, for in such case no forms would be of a sensible character. We have already contemplated the effect of these atomic affinities in the construction of stratified spherical forms, embracing constituents of different degrees of energy, and their reconstruction into analogous forms of various grades. But on the construction of these molecular forms, and their aggregations into constantly increasing spherical masses, would be all that the diversified energy of matter in atoms could directly effect. Had no other influence been induced, matter would have remained about as unfit for the production of the phenomena of nature as though it had never been acted upon by energy; for this insensible fluidity is certainly not now the condition of matter in which the visible operations of nature are conducted. The aspect of nature's incipient process requires our very particular consideration, for while we find what the affinity of atoms must have directly effected, we as certainly find that this direct effect here terminates. For any thing further than this, therefore, some adequate means must have been originated, and that, too, of sufficient force of character to reduce forms fabricated by this very affinity of atoms, which is in itself the fountain of all force; and from this source, therefore, must be deduced all the powers over matter that are now so prevalent; for we find many conditions that the attractive affinity of atom for atom could not alone directly or effectually determine. From this original root of all power, therefore, we have not only the construction of all matter into spherical forms, but we have at the same time the generation of a force little less effective in the economy of nature than the affinitive action of atoms on each other; for this affinitive energy, while immediately constructing forms, would at the same time be aggregating them together; now this it could not possibly do without imposing pressure upon the inferior forms of the aggregating substance conformable to the energetic quantity aggregated over them. Now when we contemplate the accumulated quantities in solar and planetary masses, we perceive the pressure upon their nucleus matter must be enormous, and must have vast influence in determining the relative condition of things and the disposition of phenomena. We have already contemplated its solidifying effect upon the nucleus forms of the matter composing the mass of our earth, and all the members of the solar system; we have seen how effectually it supersedes the necessity of cohesive attraction; and we shall as certainly perceive that it will equally supersede the necessity for special or final forces of any character, whether cohesive, repulsive, chemical, electrical, or polarizing.

Without this force of compression, physical nature, to our senses, would have remained a nonentity. We have already demonstrated that without this pressure upon solar and planetary masses, there could have been no light, and without light all nature would have been locked in lifeless inactivity. Therefore we have in this great and important power, and its medium of pressure, the source of all activity, and likewise the cause of all solidity. Hence from this, and the direct affinity of atoms, we shall deduce all the general process for all the relations and conditions of matter, whether solid, liquid, or gaseous, active or quiescent. However superfluous it may seem, we will here say that all phenomena in nature are expressive of the activity or motion among that matter which originated or propagated them. The necessity for this remark is caused by the fact that we are often reminded (in discussion on the subject) that such phenomena as heat, electricity, etc., are induced in sensible substances by their being invaded by other quiescent substances of greater tensity, whose assumed presence it is supposed induces such phenomena. These ideas are erroneous, for matter when still must be totally unaffective either upon substance or sense. All the activity, therefore, upon any solar or secondary mass, that is not the immediate effect of gravity, must be caused by the excitement of an infinity of miniature modification in the compressed conditions of that insensible fluid by which they are respectively enveloped and invaded, or the effect of such excitement upon the sensible matter of the substance it invades.

We have deduced the effective operations of this fluid in the production of light, heat, electricity, and magnetism, and we find these phenomena are not in any respect induced by the transmission or reception of any fluid substance from one body to another, but simply by the disturbed condition of a substance always equally present, and pervading all sensible forms, and whose elastic tension renders it peculiarly susceptible of that vibratory excitement which causes such phenomena. We have likewise observed under what circumstances this fluid and this force have become the solidifying principle by which matter receives its sensible character; and we have no other source from which to deduce the transformation or chemical metamorphoses to which substances are subject in their various decompositions, recompositions, and modifications, for without this compressive fluid, and its elastic susceptibility for high excitement, all matter would be motionless as death. And although we are unable to witness directly its formative character, or the process of its activity, still we find compensation for this in the fact that the unrestricted order of action is perfectly analogous, whether for large or for small bodies, or for sensible or insensible substances; fluid matter will assume spherical forms, either for the construction of a molecule or a solar mass, and from this determination of matter to form itself into globules constructed of strata, decreasing in energy from their centers outward, we can safely calculate on any construction, however minute or extended.

Sensible substances can only be susceptible of expansion by enlargement of their constituent molecules individually, and their enlargements can only be affected by their erecting round themselves, by the exercise of their own innate affinities, strata of less effective forms, which are always ready for such service so soon as favoring circumstances serve; thus we perceive how substances enlarge themselves without the agency of any force antagonistic to atomic affinity, and which physicists call repulsion. Suppose a substance is expanded from its most concentrated condition many hundred or even thousand times its former bulk, it is no solution of the problem of material expansibility to say that some invisible fluid has been intruded among its particles, for the expansion of the invasive fluid would be just as inexplicable. Nature can have no need of any of these transferable and fluctuating fluids, so long as the purposes they were supposed to accomplish can be brought about by the formative association of the sensible with the insensible matter, ever equally present and ready for such affinitive action, and of which no space can be vacated.

Thus, therefore, it is that the most effective forms of some substances enlarge themselves when relieved from the common atmospheric pressure which precluded such affinitive enlargements; and when the atmospheric pressure is again admitted, we find their formative forces are thereby made to yield, and a reduction to former conditions takes place. This is a simple process, but still it is effectual, and may be calculated upon as inevitably consequent from the affinities of graduated forms.

Our common atmosphere is an aggregated infinity of such forms, whose nucleus molecules are all we can appreciate; they associate round themselves the less effective constituents of that substance in which they are suspended; of some certain portion of this they may be denuded by any access of the usual pressure, and to such a degree that the atmosphere or other substance of which they are the constituents may be so compressed that the residue is made to assume the liquid character. We perceive that these compressed molecules would at once enlarge themselves by a resumption of their atmospheres or lighter exterior forms when again relieved from this extraordinary pressure; and when any space is vacated of any portion of sensible atmosphere, we find the molecules of that which is left will enlarge themselves so as to occupy the whole space equally. This susceptibility of our atmosphere and all other gaseous substances to condensation and expansion, is what is usually called their elasticity; but as there can be no elasticity in matter itself, we perceive the elasticity consists in the affinitive conditions of substances, either as a resumption of quiescence from disturbed molecular association, or a deprivation and resumption by their constituent molecules of such exterior forms of lightly affinitive matter that they could not retain under certain pressure. This facility of the constituent molecules of a substance to resume the conditions from which they have been reduced by impulsive or other forces is really what constitutes their elasticity; compression does not consist in forcing the particles of matter into greater proximity, but in pressing out that which is the most lightly affected against the affinitive forces by which it had been a part of the substance thus reduced. By the dissolution of sensible substances much of their matter is constantly escaping into the atmosphere and intermingling with it. But we are far from being satisfied that this ought to be regarded as a simple suspension of one form of matter in another, for the affinities that could effect such diffusion would be sufficient to induce an assimilation, either by the radicles of the reduced substance erecting around themselves (by the force of their own affinities) atmospheres of assimilating enlargements, or by becoming merged in the constituent molecules of the invaded substance; for did they not immediately acquire more intimate relations than is usually imagined, those substances, lighter than the air, would be forced to ascend so far above the lower stratums, that they would be lost to the earth's surface altogether, while those of greater specific gravity would remain to the entire exclusion of those lighter than themselves. Observation shows us this is not the case, for we find hydrogen gas, a substance many times lighter than the atmosphere, does not ascend far above the earth's surface unless excluded from mixing with the atmosphere, as in a balloon.

Thus we perceive the constituent molecules of this or any other substance, when mingling with atmospheric forms, are more than likely to lose their identities, their dissolution being, as we may say, almost inevitable, from their free exposure to the assimilating affinities by which they would be surrounded. Thus the molecules of hydrogen, although much lighter than the atmosphere, would not rise above atmospheric forms, because the force of such forms would be able at once to appropriate them. The sensible matter of the atmosphere would have a much greater affinitive preference for much of the sensible matter of other substances suspended therein than it could have for the insensible matter by which its forms are usually surrounded, at least so far as to cause a revolution in its constituent molecular erections. The forms of which the molecules of invading substances were constructed when thus exposed, may even to a great extent separate themselves and assume other affinitive places around the nuclei of atmospheric forms, for as their gravitating and affinitive powers, so would their places be.

The discovery that the atmosphere is composed of two separate gases proves nothing beyond the fact of its separability, and because these gases have not been further divisible, is not evidence of any thing but our incapacity further to analyze. Although we can not perceive or determine the constructive character of these recognized constituents, that is no reason we should decide that they have none; were they really ultimate materialities, how could they by any simple mixing of themselves constitute an atmosphere so unlike either? their combinations could not take place as they do, without the metamorphoses of their molecular forms from what they are when considered as simple. Why does a little solid or appreciable matter make such an amount of these gases? Or in what does the bulk of our atmosphere consist if it contains no more matter than is admitted to belong to these two simple components? By what expansive force are these component particles kept from coalescing in virtue of their gravitating affinities, unless these affinities were effective in the erection of less energetic matter around themselves? If not so, why does not this force at once reduce them to coalescent solidity? the idea so usually entertained of molecules being attractive at sensible distances and repellant at insensible distances, is utterly untenable, and worse than nonsense. These problems do not admit of a rational solution on the usually recognized principle, that the actual matter composing any substance is measurable by its ponderosity. Agreeable to this rule, we should find there is only about a fifteen thousandth part as much matter in a given space of the atmosphere as in the same bulk of gold.

The idea that only portions of space are occupied with matter at all, and that such are occupied, more or less, as the case may be, is one of the most unfortunate errors that could have ever beset physical research, as so many of the most important phenomena of nature are only determinable by a very different condition of materiality, which resolves itself into the circumstance of the sensible or recognizable matter of all gaseous or other substances being but the base or nucleus forms for their constituent sphericities. and these constructed of forms by the affinitive rule of equal distance, equal energy. By this we have all the essentials for the most perfect atmosphere, as well as any other gaseous substance, and all beautifully comprehensible by the conception, not of material quantity (that being in all cases alike), but of the differences of material energy, that being the ruling law for all conditions. Though we find the atmosphere enlarging its volumes by means of heat, it is no proof of the intrusion of any calorific substance into its midst in the manner that is usually supposed, or that any more matter has been forcibly introduced among its molecules, by which it has been expanded. What really takes place is giving an opportunity to the atmospheric sphericles to enlarge themselves affinitively by partially relieving their affinitive energy from the pressure of impact, through the undulous agitation induced in their own forms, by a participation in the calorific excitement generated in that compressive fluid in which they themselves are suspended. Were it not for the diffusion of atmospheric molecules among the matter of this fluid, we can not see why the ponderable atmospheric particles would not at once precipitate themselves to the earth's surface in obedience to her common gravitating attraction; for, opposed to this common attraction, were there not a mutual affinity of forms and a mutual affinity of a formative character among matter in contiguity, there *could* be no atmosphere at all. What may we suppose to take place in any substance where ponderable substances are suspended in such as are less so? certainly something more than a diffuse suspension, for that could not be in itself sufficient; and nothing less than an effective reconstruction of the combined whole could prevent the precipitation of the most ponderable; and nothing short of this formative action could even cause such equable diffusion, as we see often taking place, at all.

But when we consider the earth's vast envelope of insensible but highly compressive matter affinitively associating itself with a sensible base, nothing is more evident than the construction of our atmosphere, or that of any other substance, however etherealized from our powers of observation, and even without any sensible base, why it might not, by the formative affinities of its own matter, as well construct as perfect a substance as any now palpable to our senses. All matter, with any energy at all, when favorably circumstanced, will exercise that energy in the construction of forms, the fabrication of substances, or the metamorphosis of molecules, and all must necessarily have some effect in the general disposition of things agreeable to circumstances, which are even thus caused to be infinitely variable.

It will be perceived that we totally repudiate the idea of different quantities of matter in the same bulk; we hold it to be everywhere equal in quantity but unequal in energy, and the difference of substances to consist in the relative quantities of the sensible and insensible with which they are composed, and the manner in which these are associated, for by this inequality of energy we have all the modifications of material substances.

Agreeable to this formative system, therefore, it will readily be perceived that when the atmosphere's constituent sphericals are by any means compressed beyond the usual rate, their exterior forms will be forced from their affinitive relations, hence the globules will thereby be reduced, and the substance of which they were the components made to occupy a less space; and, on the other hand, when the usual pressure is by any means relaxed, the forms will, in the same ratio, enlarge themselves by affinitive additions to their exteriors. This partial relief from the usual pressure is given by the relaxed alternations, furrows, or depressions of calorific wavelets excited in the associate fluid of the atmosphere, and applicable to any fluid as a cause of expansion. All the elasticity of expansions or condensations in any substance consists in the deprivation and resumption of the exterior matter of their constituent forms, while a dissolution or decomposition amounts to a disintegration of the forms themselves.

Thus we find all the general facts and processes, causes and consequences, of the formative character and conduct of our atmosphere, which we may consider one of the great laboratories of nature in which any kind of matter in solution may become assimilated, modified, metamorphosed, or transmuted into the radical constituents for some other very different substance, so as to supply what may be wanted in the active and changing economy of nature, for the construction of her infinity of products; for we must be aware that the atmosphere has in all ages furnished a great part of the food for plants and animals without becoming at all exhausted. It must, therefore, have the faculty of fecundating replenishment, or from whence all the matter constantly extracted, particularly carbonaceous matter, which is assumed to have been abstracted from thence and laid up in the bowels of the earth in coal, carbonaceous limestone, or other strata, in very great abundance. We do not acquiesce in the assumption that all this vast accumulation of carbonaceous matter constituted a part of the primeval atmosphere, and of which that great envelope is now divested. But from what it necessarily has furnished, we can not see that without powers of transformation how it can remain unexhausted, but we can very readily comprehend how the insensible envelope should be always able to form and sustain a certain quantity of this sensible atmosphere so as that it may not be exhausted. The atmosphere at this time is certainly not to be considered as the residuum of the first-formed atmosphere, for in it there is evidently a perpetual change going on, amounting to a metamorphosis to and from the condition of its constituent matter. Had all the carbonaceous matter now concentrated in the strata of the earth prevailed in the atmosphere in primitive times as carbonic acid gas, it would by virtue of its greater specific gravity have formed a deep understratum resting on the solid surface, to the total exclusion of the atmosphere from that surface, for the lighter fluid could not descend below that which was more dense; and even imagining it had mixed with the atmosphere, it must still have been so very dense at the earth's surface, because of its specific gravity, as to disqualify it for administering to the functions of life, if not for the preservation of organic forms. From the assimilating tendencies of matter with matter we may regard its replenishing abilities compensatory of the matter abstracted therefrom by substantive formations to which it is tributary, for it is not in the order of nature that the atmosphere can be exhausted of any property essential to its own proper condition, or to the condition of any other substance of which it is the source, or order of things to which it is essential.

The energy attaching to the matter of which our sensible atmosphere is formed is unquestionably the best suited for its particular offices; but the same energy would altogether incapacitate it for the atmosphere of the largest planets of our system, because of their much superior pressure of envelope. Let us consider what would necessarily be its condition in a mass having a central force of gravity such as Jupiter, and under the pressure of his vast envelope; these would afford forces sufficient to reduce the most affective molecules of our sensible atmosphere to a condition of total solidity. Matter with so little energy as to be unknown to us in consequence of our earth's inferior powers of attraction may, in all probability, form the aqueous ocean for such a body as Jupiter, or at least a condition of matter that serves in its stead. It is likewise evident that organisms constructed of matter such as ours would be altogether unsuited to such gravitating energy as that planet exercises, therefore we may justly infer that the energy of its atmospheric matter, and that with which its organisms and surface substances are constructed, is of that grade which is proportional, being inverse in energy to the excess of his gravitating power. But with all this we would not be justified in the inference, that this excessive gravitating pressure of great bodies would be followed by the greater density of their solid nucleuses, for it must be observed that equal energy and bulk would equally begin the solidifying of any mass, therefore solidity must have been effected in the molecular matter of Jupiter when he had attained the same size as when solidity began in the matter of our earth, and subsequent to such solidification it could not have become more densified. This solidity therefore having taken place equally under an equal amount of pressure, the center of the largest solid body could be no more dense than the smallest, because this solid framework when once formed could not be condensed into smaller space by any further accumulation of pressure.

Our ocean is admirably qualified for terrestrial purposes, but with the energy its matter now possesses, it would be converted into something else under the influence of Jupiter's attraction and the pressure of his vast envelope; and so would it with any of the larger planets. Even with us, constant calorific agitation of a considerably high order is necessary to keep the aqueous matter from solidifying; and with a much greater pressure and central gravitating force it could not be prevented at all, and may have formed, under such circumstances, something very different. This calorific excitement, always at less than thirty-two degrees, would make aqueous matter continue to be as solid as marble. But although the matter of our ocean or atmosphere would not be conditioned for such office in the larger planets, that is no proof that they are not equally well supplied with both in matter perfectly suited to their condition and their necessities. However, we will not now speculate on the particular characteristics the enveloping substances may assume in other planets subject to other orders of association and produced by different degrees of force, but we will endeavor to deduce the cause of the terrestrial characteristics of this matter. We find it assumes three very different conditions—namely, solid, liquid, and aeriform, and although usually and most plentifully found in a liquid state, it requires but small change of circumstances to convert it into either vapor or solidity, which last would be certain, as we have seen, were it not for the constant excitement of calorific action; for whenever this action is reduced to a certain degree, we find it at once assuming solidity, and when the action is augmented to another certain degree, it is resolved into vapor. The process is easily understood by which these transitions are effected; in the first place we must consider it would have ever remained in a state of vapor but for the vast compression of both the sensible and insensible atmospheres, and this compression united to its own energy would reduce it to perpetual solidity, were not the compressive fluid itself under constant calorific excitement, by which it is to some certain extent relieved from the effects of this pressure. We find when the excitement is to a certain degree reduced below that which insures fluidity, and the constituent forms in consequence left more motionless, a metamorphosis is effected in the substantive condition of the mass by the affinitive inability of its molecular forms to retain their structural characteristics; for, under such circumstances of pressure and intestine quiescence, the affinitive balances by which the fluid sphericity of forms had been sustained would begin to give way by being thus subverted, and the native affinities left to operate with their greatest force in the lines of shortest passage and least resistance between the affinitive centers of constituent molecules, whereby stratums of the most ineffective forms surrounding such centers in the formation of constituent sphericles would leave their places, and allow the nucleus forms to shoot in needles from center to center of the forms which had composed the fluid condition, and thus all becomes a solid mass, because of the common compression no longer acting equally around the constituent sphericles, retaining them in their fluid conditions; this transformation of the aqueous condition begins to take place several degrees before the substance assumes sensible solidity. In such cases of solidity, the compressive medium being excluded from between the points of contact, would act interstitially and in all its vigor only between where the consolidating points were in contiguity, and this pressure, in that case, acts as their adhesive force, their former atmospheres, which caused their fluidity, now forming a part of that fluid medium. by whose compressive force they are thus consolidated and sustained in this forced order of affinitive construction, as much as if they were in cohesion by virtue of some special attraction existing mutually among themselves. A slight observation on substances in general, and particularly on solids, must satisfy us that they contain much matter that would be insensible were it not so affinitively associated, and which on being divorced from its sensible relationships becomes again, to our senses, a nonentity. On a comparison of bulk with the specific gravity of even solid substances we find great differences. A lump of ice, glass, or rock-crystal, for instance, seems as imporous as gold or platinum, while they are not much more than a twentieth part as heavy, and would seem by that method of measuring the quantity of matter, not to contain more than about a twentieth part as much. Now how can this be, if weight is to be considered a criterion of quantity? what may be supposed to make up the balance? Substances are certainly measurable as to bulk when their constituents are solidified, but their constituents may be of different grades of energy, both ponderable and imponderable; and the specific weight of any substance only signifies its affinitive quantity. We know of no reason why the imponderable when associated with the ponderable may not become both solid and sensible; and if we are unacquainted with any solid substance destitute of weight, that is no good reason why we should consider weight to indicate the whole quantity employed in the construction of a substance.

As we have before remarked, we can not conceive it necessary that the particles of matter should be separated by space in order to cause bulk without increasing gravity, or that repulsive or counteracting forces should be introduced in violation of the very law by which matter assumes a substantive form. There must be unequal energy upon the particles of matter, otherwise there could not be all the infinite variety which embellishes the works of nature.

Our aqueous matter, therefore, even its liquid state, may be looked upon as being composed of by far the greatest portion of insensible matter; for let its sensible constituents be decomposed and reduced to solidity by their affinity for other solid substances, we should in such a case be able to retain all the ponderosity of the fluid, though but a very small portion of its bulk, for the dissociated insensible matter would be no longer there to make that good. Thus while we find the ponderable constituents of our aqueous fluid constituting but a comparatively small part of its bulk, we at the same time find its solidifying susceptibilities are not (as thus associated) thereby abridged; for notwithstanding its usual fluidity, it is so susceptible of solidity, as only to be prevented at all times from assuming that condition by the constant excitement to which it is subject. Whenever this excitement is to a certain extent abated, the energetic nuclei of the aqueous molecules are unable to retain as much of their atmospheric matter and spherical nature as will make good their fluid affinity, and their energy takes a different direction, and solidity ensues.

Now this change of circumstances does not only seem to have solidified the sensible portion of matter that was a fluid, but to have metamorphosed the insensible portion into solidity, or it could not have retained its former bulk. Considering the constitution and conduct of this transformable substance, as caused by its own affinitive action, under the pressure and exciting influences to which it is constantly subject, we become inducted into the general processes by which the different grades of energy effectuate upon matter the constantly fluctuating phenomena of nature. We have considered this substance in its aeriform liquid and solid conditions, which are certainly in their characteristics as different as conditions can well be. Yet we may readily perceive how little is required in the change of circumstances to make it assume either of these very unequal states. A few vibrations more or less in the pervasive fluid is all that is required to convert it either into a solid, a liquid, or a vapor. Now why should we suppose any other force at all necessary for these effects other than what we find in the common gravitating affinity of atom for atom; we have already seen that it alone is the cause of the great compressive fluid and its structural formation, so susceptible of high elastic excitement, and we must consider it the indirect cause of all the modifications induced in phenomena under the operation of this compressive force, and the excitability of its elastic tension.

It is beyond measure surprising that physicists should so long entertain the preposterous idea that a material substance can be enlarged by the intervention among its constituent particles of some repulsive but otherwise incomprehensible existence, acting intermittingly in positive contravention of the eternal and immutable principle by which matter is made to gravitate to matter. Every one is well aware of the expansibility of substances, but we have seen no cause assigned for their enlargement that is not more incomprehensible than the phenomena for which it is attempted to account. But the enlargement of substances without the addition of sensible matter is a circumstance not difficult to be understood when we can so readily deduce it from what has already been demonstrated in the fact already so often noticed, of the gravitating affinity of matter having aggregated round the sensible part of our earth a vast but insensible envelope, without whose instrumentality many important phenomena are altogether inexplicable, and among others that of the expansibility of substances is not the least considerable.

When this great truth is once admitted, the whole mystery is, in a great measure, solved; and admitted it must be, for all sensible phenomena are found to prove most conclusively its existence, even were it not itself deducible *à priori*, which testifies in its turn to the cause of the phenomena. With these premises let us now consider and illustrate what takes place to induce the expansion or contraction of substances when their relative affinities should have ruled them to rest; and for that purpose let us again consider water, and what takes place with it to cause its transitions. Every one is aware that, by heating water from 40° to 212°, its bulk is very considerably enlarged; now, as we assert there is no repellant power necessary for this enlargement, let us see how the assertion is to be made good: in the first place we must ascertain in what the heating process consists; this is easily understood when we consider the excitability of that material medium by which all sensible substances are pervaded, and whose excitement they are more or less susceptible of participating. This excitable action being generated by the affinitive activity of the constituent forms or molecules of substances during the process of what is called combustion, they are rapidly propagated by the intermedium of the invasive fluid into the water, which enables its constituent forms affinitively to add some of the matter of this fluid to their own circumferences, by which they are made to occupy more space without any additional ponderosity. They are, by this enlargement, forced upward by their more dense associates, and a continuation of this process presents successively the molecules of the aqueous matter to the action of the energetic impulsions until an excitement is got up in the whole substance, as indicated by 212°. To this extent it seems that the constituent molecules will receive the impulsions conducive to their atmospheric enlargements without assuming the aeriform condition. From 32°, therefore, to 212°, under common atmospheric pressure, is the range through which water will receive excitement without undergoing any considerable intestine revolution. When at or below this lowest number, we have already said, the molecular economy of its fluid condition becomes altogether subverted, and their affinity induces solidity; and when they receive the excitement up to 212° they are again revolutionized into a new order of affinitive association, producing the aeriform condition, which likewise has its limit in the constituent globules of steam.

This vibratory action is more freely propagated in some substances than in others, depending on the manner in which such substances are affinitively constructed and associated in their own matter with this excitable medium. And when the aqueous or other forms are in process of transition into the aeriform state, the metamorphosis can only be facilitated by the reception of this excitement. These transforming molecules, therefore, being the most ready receptacles of its action, will thereby enlarge themselves to their limit, and rise above the liquid pressure imposed; and the molecules that are in most immediate communication with calorific action would receive all the generated excitement in succession, and enlarge their volume seventeen hundred times what it was while in the liquid state, that being but still 212°, as before their transition; this receiving of a great influx of excitement, and still indicating but 212°, only proves their capacity for impulsatory action to be greater than the substances from which they, in these revolutionary enlargements, originated. This capacity or indisposition to impart their excitement to any other substance so as to raise its temperature above 212°, is caused by the excitement being only equal to the enlargement and condition of this new-formed substance, with what may be allowed for the constituent affinity of sensible matter in its construction. Thus we see why the large accession of calorific excitement imparted to the generating steam does not raise its temperature above 212°, is because this expanding substance is its most ready recipient, and why it will not impart it to any other substance indicating the same temperature is because they being equal there is nothing to induce a transfer; and why it can not be induced in water subject to the usual pressure at a greater rate than is here indicated, unless when the heating process is continued on a confined fluid far beyond the point where vibratory impulsions capacitate aqueous matter for the more free admission of excitement in and among its forms, is because the revolutionary molecules require to be enlarged by its means seventeen hundred times their former bulk; different substances being differently capacitated for entertaining and propagating calorific excitation according to the affinitive association of their sensible and insensible components. We find in the generation of steam pulsations propagating themselves from their source into the water and its expanding molecules, even through the metallic vessel in which the water is contained, and that, too, in preference to passing up the chimney or into the atmosphere, and we need feel no surprise at this when we consider that the excitable medium pervades all substances, and they are only excitable from sympathy.

It may be a question how the water in a steam-generating boiler (being a perfectly tight vessel) could enlarge itself 1,728 times its former bulk by additions of matter which seem so evidently shut out. This would certainly be an impossibility were all matter such as our senses indicate; but when we admit the principle that matter is a universal equality, and that differences simply consist in affinitive modifications of this eternal unity, we shall then perceive that there is always the same quantity of matter in a steam boiler, whether it be modified within our recognition or not.

Now, in virtue of this vibrating agency and all-prevalent matter in and by which it is propagated, the water in the boiler is enabled to form affinitively with this insensible matter a substance 1,728 times its former bulk. To this new substance, thus affinitively associated, the containing vessel is no longer pervious, notwithstanding it may often be under vast elastic pressure by the steam being confined and compacted by a continuation of the process of generating this calorific excitement; and the more this is continued the more compressed will be the constituent globules, and the more condensed the vibratory action in them. By this condensating process steam acquires great expansive powers; for its molecules under such accumulating pressure being unable to enlarge themselves to the extent of their highly excited capacity, will effect such enlargement as the compression is abated; and this elastic expansion will not be by the exercise of any repellant powers among its molecular constituents, but by adding to their surfaces more matter in satisfaction of their affinities while under this excitement; this they are enabled to do in the reciprocating relaxations of the undulous wavelets induced in them by this calorific action. By this process, as it will be seen, a very great amount of pressure may be got up, not by introducing any more sensible matter into the boiler, nor by any repellant power in the matter therein, but by making that more effective because of its molecular enlargements allowed in the alternations of relaxed elasticity infinitely propagated in the contained fluid under the common pressure of the insensible atmosphere. Were it not for the vast pressure of this vibrating fluid, the most of the matter of our earth would be an invisible fluid, for without its compressive impact and consequent cause of solidity not a single ray of light could be intercepted by any substance. It is only in a mixed, solid, or transition state that substances intercept the rays of light, because in such cases affinities are more or less embarrassed in the production of constructive association or disposition of forms; and did not the direct effect of attraction induce this pressure, the condition of our earth's matter would altogether disqualify it for the exhibition of any sensible phenomena whatever.

Vast therefore must be the pressure of impact which can reduce the matter of our earth from what it would otherwise be to its present condition, each form being necessarily surrounded by an atmosphere of less energetic matter, of which this compression must to a very great extent have divested them before they could have constructed sensible conditions of any kind. From this reduced condition the molecules of water are excited into a partial recovery of themselves by the calorific agitation induced in the compressive tension of the very medium which causes their reduction; for to whatever extent they can be relieved from such pressure, a corresponding restoration to enlargement must be an inevitable consequence, from the mutual affinity of forms thus arbitrarily divorced, causing, under these more favorable circumstances, a restitution of some part of the matter of which they have been so forcibly divested.

The object of the present undertaking being but the exposition of the great *general principles* from which every operation of inorganic nature is deducible, our effort at the application of these principles is to introduce into the different departments of physics such examples as may serve for practically working the great problem, such as will prove that all the infinite details are readily deducible from the same all-potent powers. With this object in view, we have contemplated the general effect calorific action has upon the aqueous matter of our earth in inducing the differences in its affinitive conduct.

It will now, perhaps, be as well to indicate some of the many ways by which this action is itself generated, besides those already mentioned. Among these, combustion seems to contribute very considerably to the evolution of calorific action; but as the name combustion signifies nothing but the decomposition of substances, without indicating the process by which the decomposing matter generates the excitement essential to its own dissolution, it will be necessary to ascertain what conditions (constitutional or induced) can cause such high excitement, and its wide and rapid propagation.

We observe that the substances whose decomposition is best calculated to cause calorific action are usually those whose components are most readily metamorphosed into more things than one, as circumstances may decide. For example, let us suppose that matter not readily perceptible to our senses may, by the formative effect of organic action, be fabricated into the branch of a tree, we find it thus becomes a substance of no inconsiderable consistency, but for whose preservation a provision must be made. The organic forces under which it was formed having ceased to act, can not be considered as longer conservative of its state, but, like every other palpable substance when once constructed, its preservation is secured by the common medium of compression, under whose force alone any substance becomes solid. Now let us observe the process by which combustion can again reduce it to invisibility.

We have but to excite the compressive medium (in proximity with each combustible substance) into a high state of calorific activity, and it will so propagate itself that the pulsations and pressure will be insinuated between the constituent molecules at their points of junction, so that the molecules will be again liberated, and these liberated molecules will enlarge themselves by reassuming their atmospheric envelopes (of which solidifying circumstances had deprived them), and will reassociate themselves in other forms and conditions in the construction of other compound substances, for no gaseous particles can be for an instant at rest till they have arranged themselves to the satisfaction of their affinities.

It is evident that substances can not form new affinitive associations unless their constituents are sufficiently liberated from former relationships and attachments, the most divisible conditions, therefore, must be best calculated for effecting such new order of relationship; hence we find these associate combinations and formative conditions only taking place among matter when most in the order of fluidity; and this fluidity of substances is always more or less affected during combustion, because then the components of such substances are forced, by their exposure to this high temperature, to participate so largely in the excited action of the excitable fluid by which they are invaded, that their affinitive integrity is thereby abrogated, at least so far that this compressive fluid is admitted between the consolidating points, by which the substance is no longer a solid. It will be observed that the components of substances are not all set at liberty under the same degree of excitation; for example, the hydrogen contained in coal and other combustible substances is usually evolved in a gaseous state, before the other constituents of the solid are excited to a red heat; but this evolving gas will still admit of further combustion when subjected to a greater degree of calorific action, as we often see in the artificial processes of generating light and heat for the necessities and comforts of life. This can only be caused by the reconstructive action of the liberated molecules with and upon the matter of the medium in which the process goes on; and thus it is that decomposing substances generate the very excitement that consumes them. In this liberation of carbonaceous molecules we have the excitement that causes a dull red light, induced. in a great measure, by the action which takes place in the formation of carbonic acid gas, the two forms of matter that compose this substance being the most suitably conditioned to satisfy their social affinities for each other when subject to this high excitement, and in this act of union they produce the very excitement that dissolves the solid and resolves the new substance, and so are they enabled to continue their formative operation until the whole carbonaceous substance is consumed. An identical process is consequent in the combustion and reassociation of hydrogen gas, only differing in acuteness of calorific action, as is evident by the brilliancy of the light thereby induced.

Now, while we are satisfied that sensible substances are susceptible of such excitements as induce the sensations of light, electricity, and heat, we are forced to infer that there must necessarily be some medium acting on them, and common to all, which can thus exhibit itself and disturb the whole force of their affinitive relations, for it can not be imagined that their own constituent forces could agitate for their own dissolutions; and even were this the case, how could we be impressed with the sensations of light and heat by which we are made aware of the fact when we are not in contiguity with them? If the source of this agitation were within them, we do not see how it could agitate itself out of them so as to affect other sensible substances apart from them. We feel the sensations of heat and light while we are far from contact with the substances producing them. Can any thing be more conclusive in this case than that there must be an intermediate substance highly susceptible of receiving and propagating these excitements? for if not, they could not be so transmitted from substance to substance. We will not insult the good sense of the age by the supposition that any one still entertains the idea that substances during combustion send forth from their own mass sufficient matter to effect surrounding objects, and excite the sensations of heat and light by this mode of its transportation. These destructions and reconstructions of substantive forms or conditions by combustion being effected in the midst of a highly elastic fluid, the molecular activity of the metamorphosing matter will generate therein pulsatory action proportional with the time and quantity of matter consumed, or rather transformed, by which means the matter of a decomposing substance is made to administer to its own dissolution. All substances may be considered more or less susceptible of metamorphosis by excitement, if such can be induced in the requisite degree, and all substances while in transformation are more or less the means of generating such excitement, although it may not at all times be otherwise practically appreciable. High action usually indicates itself by the exhibition of heat or light, or both, these being the sensible signs of the existing excitement both in the substance and in the insensible medium of intercommunication. The degree of diversified action induced by the combustion of substances to which our nerves of sensation pulsate in responsive unison, are but modifications of the pulsatory excitement generated by the metamorphosing matter of sensible substances in the great compressive fluid in which alone such excitements are propagatable.

This medium, so highly excitable and at the same time conservative of all sensible conditions when in its usual quiescence, is certainly the best conceivable intermediate agent by which the sensible matter of such a mass as that of our earth should be put in connection. It may be considered as the great seat of the nervous excitement to physical action, for, because of its subtilty and tension, its tissue must ramify every known substance in nature, and conduce to their condition, whatever that may be found to be. Indeed, without its instrumentality, there could be *no known substances*, for from it they derive what is to us their substantive character; and unless it is embraced in our contemplations as a general cause, most of the phenomena of nature will continue to be perfectly incomprehensible.

So simple and unassuming are the great principles of action operating the great purposes of nature, that unfortunately they have been altogether overlooked by philosophers and physicists, and the character of true physical agencies very much miscomprehended.

But however simple may be the system of means which the Almighty has adopted in carrying out the great eternal scheme of the universe, transcendentally consummate must be the skill that could devise and make such final and immutable application of first principles as would work out the great chain of connected events in all their windings, unfoldings, and eternal continuations, without any omissions or subsequent emendations. What circumstance can we conceive of that would have been more conducive as a means to existing conditions or indicative of their cause, than that mighty but unseen medium of force and action whose existence is so clearly deducible from the affinity of atoms as relatively impressed, and whose power of pressure or excitable impulse every molecular form in every sensible substance is made to feel? Without a knowledge of this agent, the united wisdom of the world has applied its powers in vain to deduce from nature a rational cause for nature's manifold phenomena. The facts she presents (complex though they may seem) being but a part of that unity which is admitted to prevail in the universe, is conclusive that she has some general rule or law of their action, and which must likewise be the law of their creation; for while there is a unity in nature, there must needs be a unity in the law of that nature. The proper conception of that law is certainly as essential to the solution of phenomena as it was to their creative development, for what could resolve the phenomena of physics must be the only proper solvent of the problem of physics. We can not see how the usual scheme of philosophy can be considered as contemplating such a unity of law, while they inculcate the idea of divers and conflicting forces of ultimate or fundamental character, and many of them perfectly antagonistical to each other; all of which seem by their systems to be essential more or less for the generation of every form that matter assumes; but we can not even see by their calculations how these antagonistical forces could be effective of conditions, and more particularly in expansive substances, where repulsive forces are assumed to be the most effective; for if there *is* any unity of law, rule, or action between attractive and repulsive forces, we acknowledge our inability to comprehend it. The affinity of atoms, and the force of pressure incident to aggregated masses and common to the whole, are certainly of the same order of power, for this force of pressure follows as a necessary consequence of the fundamental affinities, and only operates in so far modifying their measures as to make them evolve phenomena in accordance with the scheme of creation. Every existing condition therefore being altogether induced by the affinity of atoms and force of impact, would have an endless perpetuity, were it not for some cause of motal activity not in the substances themselves, either resident or originative. The activity or transformation of substances, therefore, must be altogether attributable to extrinsic cause.

Chapter Eight.

Perpetuity of Planetary Motion—Aggregative Substances—Process of Combustion—Electricity—Expansive Substances.

We have fully demonstrated the primary cause of all repetitions of activity to be in the motions of the planets round the sun; that being the only relative condition of substances which can not rest, must be the sole source of all other forms of activity that are so perpetually made to transpire. But this motion of the planets could be no source of activity at all were they as isolated from the sun as they seem to be. The purposes of nature, therefore, could not be fulfilled were it not for the intermediate matter we have indicated, and even this would be ineffective upon sensible substances were not that with which they are in contact under very high progressive compression and of elastic construction, and physically graduating into the metaphysical, so as to be acutely susceptible of reciprocating extrinsic and metaphysical action, and imparting it to the sensible substances with which it is in associated contiguity. Had it been under any circumstances essential that we should have been endowed with a sense adapted to the direct recognition of this great medium of power, or had our physical welfare depended upon our being apprised of its existence in a more sensible measure, it certainly would have been given us, or it would have been such a failure as we nowhere else find in nature.

The senses with which we are endowed derive their faculty of affording to us our greatest pleasures, by their responsive adaptation to the pulsations propagatable in this very medium of which heretofore nothing has been known. Indeed, were it not for this substance, we could have no senses at all, for it not only excites in them a sense of light and heat, but it even excites the very sensitive organs themselves into *being*, for without light and heat there could be no vitality on which to impress sensation. From this substance, therefore, and its system of action, we derive our organs of sense and all the pleasurable excitements they are so susceptible of imparting. By means of this compressive medium, and its susceptibilities for action, the effective process for the production of light, heat, electricity, and magnetism, and all other following phenomena, reveal themselves in all the simple and intelligent harmony of their own intrinsic nature, against which no other conceivable scheme of physics can by any possibility prevail, for its foundation is deep as the fundamental affinities of nature's eternal truth, and lasting as the irrevocable counsels of the everlasting God who determined them.

But however essential to light and heat we may consider this compressive substance, we are by no means to regard it as being in itself either light, or heat, or electricity, or magnetism, for no quiescent substance, of whatever sort, could by any possibility produce these excitements or sensible effects; therefore they are to be regarded as the sensible expressions of its pulsatory action upon our organs of sense and other sensible substances, for if the simple presence of a fluid substance in a state of perfect quiescence could not operate sensibly upon our sensitive organs, it would certainly be equally ineffective upon other substances. Therefore we may consider this fluid as continually present, and in contiguity with every sensible thing, and always effective upon them by the force of its pressure, as modified by the measure of its excitements. Now it will be perceived that this constant presence and pressure would be to them a perpetual preservation, so that all would have remained in perfect rest only for the elastic construction of the fluid, which renders it so readily susceptible of certain excitements or undulatory modifications of its compressive tension. These excitements, therefore, generated and propagated in this fluid, are to be considered the sole cause of nature's activity, because of their modifications of the compressive restraint to which this and through this all other substances on the face of the earth are subject, permiting the mutual affinities of liberated and approximate forms to exercise their social affections in the formation of those substances, for which surrounding circumstances are most favorable. It will be seen that we not only regard this medium as being propagative of such pulsations as excite the organs of sense, but we even go so far as to infer that it is solely propagative of all organic existence; for its excitement being the source of light and heat, it is thereby evident that without this medium in which they could be propagated organic nature would be a nullity.

We, in the first place, and without any reference to its subsequent action, have deduced the *existence* of this vast insensible atmosphere to have been necessarily consequent from the discriminating application of the attractive energy to atoms, and their aggregation into our earth's mass. In the second place, we have shown how highly essential the existence of such a substance is for the subsequent development of phenomena; we have shown that without its instrumentality there would be neither heat, light, electricity, nor magnetism, and consequently none of the phenomena attributable to their action. We hold it to be the cause of the coruscations of light which exhibit themselves over the poles of our earth, that being a proof of its presence and activity. We consider it as a great ocean of insensibly affected matter, in which the sensible quantity composing our atmosphere, and all other uniform substances, are in associate diffusion, it being the source from which their sensible constituents derive the matter that makes up their insensible quantities on assuming gaseous expansion. To its presence and pressure we attribute the comparative solidity of all substances, and to its action we attribute the solution or dissolution of sensible substances, in every variety, aspect, or order of change, whether effected by what we call decomposition, combustion, electro-galvanism, evaporation, or exhalation. We have deduced its most permanent relations with other conditions of matter, and altogether established its claim so uncontrovertibly, as to consider the presence and activity of this substance to be no less essential for the molecular formations of what are usually assumed to be the chemical constituents, with all their subsequent combinations or associations; for it can only be in and under the different modifications of action and pressure, as induced in this medium, that the constituent forms of chemical compounds can practice their affinitive preferences, and it can only be by their ponderable constituents associating with less or more of the matter of this unseen substance, that sensible gravitating substances of any sort can augment their own bulk beyond a sensible solidity. Indeed, the difference in ponderosity of fluid substances is altogether owing to the particular order in which the insensible portion of their matter is molecularly arranged with that of their sensible portion. When we consider that ponderosity is no proof of quantity, because of every substance of the same bulk containing precisely the same amount of matter in some way incorporated therein, it will certainly be much more explanatory of circumstance as they exist than the supposition usually entertained of repelling forces; for we have no difficulty in perceiving how the sensibly affected forms of any substance under certain pressure can add to their bulk from this insensible source on any relaxation from such pressure.

As the compressive impact of a fluid substance must unquestionably be proportional to the gravitating force of superincumbent matter, it must necessarily follow that in solar and planetary masses (they being spherical) this force of pressure must be at its maximum at their centers, and from thence decreasing in the inverse ratio of the distance to its junction with what we have called metaphysical matter.

Now, as we hold there is no force in physical nature that has not its origin in the gravitating affinity of atoms, this force of pressure originating therefrom must unquestionably be the grand source of all power effective in any way of sensible phenomena as consequent from the pressure incumbent on whatever planes of parallelism around the spherical masses by the superior matter directing its energies downward to the center of gravity common to the whole mass. Now, on these planes of parallelism that comprehend our earth's visible surface, we are satisfied that the pressure of matter downward secures what stability there may be in existing conditions, and while this is so evidently the case with gravitating substances of a sensible character, we see no difficulty in the admission of a pressure imposed by insensible matter having the same center-seeking tendency; for without such pressure they could by no other effort of nature have become the sensible substances they are. And even were the conditions of such substances solely caused by the constituent energy of their own substantive matter exclusively, each substance would have its own independent condition permanently secured by the force of its own innate affinities, so there could be no possible *action* in connected unity, for each substance thus secured would be in itself unqualified either for the excitement of self-action, or any reciprocating excitement of action with other substances.

Now, as changeless inactivity is nowhere the order of nature, and as sensible conditions are by no means the effect of their own direct affinities, we are compelled to conclude that they must all be extensively operated on by a force not immediately of themselves, or their own direct action, but in a substance by which all are connected with all. And even with such force their conditions would still be permanent were it not a force susceptible of considerable modifications, for this pressure downward being the accumulation of all power over that parallel of our earth's spherical depths, on which it may be calculated as operating, would hold all things in quiescence were it not itself excited into action. In that part or parallel of it in which we have our residence, this force must be the most powerful nature can there apply, and would militate against all motion or activity of any kind were not its own medium highly susceptible of such action and modification as would enable sensible substances to metamorphose their condition; for otherwise, instead of causing activity in matter, it would determine its eternal immobility or quiescence.

This motionless condition of matter would not be obviated were the character of this compressive fluid such as our senses estimate matter to be, for in that case it would be utterly insusceptible of such excitation. Being destitute of any of these recognizable qualities, most unquestionably the better qualifies it for its very important agency in the determination of material conditions and their transformations. The constituent forms of this all-important substance, when unassociated with sensible matter, are so inert, passive, and pervasive, as neither to obstruct, or be obstructed by, any sensible substance, however solid. But still its existence, as we have seen, is clearly demonstrable by deduction in the first place, and then by the effect it has on our own senses, and on every substance of which they have cognizance. And as respects its own inherent constitution, whatever may be the pressure of impact to which it is at any situation subject, we perceive that at the plane of the earth's parallel in which our social relations with matter are situated, its constitutional elasticity is most favorable for activity, and in that consists the sole possibility of any force being able to effect its disturbance, and by its disturbance the general activity that prevails in nature, for were there no favorable and excitable relaxations of this great force of pressure, activity could nowhere prevail.

But while relaxations in this substance are so essential, there can be but one possible process by which they can be affected, and that is by agitating the equability of its elastic tension or constitutional affinity by a partial disassociation of the differently affected molecular forms of which this substance is constituted, and their propagation in a series of reciprocating wavelets or undulatory excitement. It is evident that the less affinitively bound the matter of any substance may be, let it be under what pressure it may, the farther such pulsations are likely to propagate themselves without becoming extinguished by their affinitive effort at readjustment, or by the force of any resistance in their path. The greater the force of constitutional affinity the less readily disturbed and the more readily resumed will be its equability. In this homogeneous fluid these pulsations are propagatable without any general expansion of the pulsatory substance taking place, because there is no other matter present with which to form an affinitive fellowship, and this we may consider to be the order of propagation in that insensibly affected matter with which our common atmosphere intermingles the least, for this combination becomes so affinitively constituted, that no pulsations of acute character are propagatable in it, except in the most tardy or reluctant manner; and hence it is that the atmosphere is so good an electric isolator. And even so imperfectly does it conduct the calorific excitement, that this action can be induced in the insensible matter of substances to a very high state of condensation, because the pulsations can not freely pass away into or through the common atmosphere surrounding them.

When the condensation of excited action in the calorific form takes place the substances become sensibly enlarged, because their sensible constituents participate in the excited action, and thus afford the insensible fluid an opportunity to insinuate itself more freely and affinitively among them. When this action becomes sufficient to overcome the cohesive pressure that causes solidity in the molecules of any substance, or of the components of any substance, they are thus far at liberty to enlarge themselves by the exercise of their affinities for other matter. This partial liberty is procured for them in the relaxations or alternating wavelets induced in the compressive medium. But however minute we may consider these excited wavelets of compressive force to be, still material forms being their medium of action must be much smaller than they, and therein may affect their own affinitive enlargement by surrounding themselves with less sensible matter as atmospheres.

This expansion of substances thus induced is not for a moment to considered as a separation of material particles from each other by their own inversion of energy, or by the intrusion of any other property or principle but matter. There being nothing else in nature that could intervene for their expansion, or the occupancy of more space, for what is there that can be conceived of which would occupy space, positively and physically, but matter? it could not be occupied by vacuity, for such is a perfect nonentity that could occupy nothing with substantive existence and form. But notwithstanding vacuity or free space is usually considered the great theater of physical action and material motion, and the most extensively prevalent of all, and in every department and substance, more or less, no one has yet supposed nonentity can be an attribute of the Omnipresent Being; how, then, is any part of the everlasting expanse to be vacated? If we consider vacuity at all, we must consider it as eternally existent and independent of Omniscience, which is an utter impossibility, for He and his attributes are the embodiment of time, space, and eternity. We have defined His attributes to be mind, matter, and energy. In what part or point of the universe, therefore, could He be divested of either, so as to leave a vacuity? One attribute of His being is certainly as essentially omnipresent as the other; we can not conceive how one part of an infinite being could be clothed with an attribute of which another portion was vacated. He most unquestionably could exercise his energy at will, or he could not be omnipotent, but that energy must take effect on some substantive principle in himself, not on *mind*, for mind gives to energy its direction, and is its incitement to action. It must, therefore, have been matter, against which energy could be directed, but it could not have been directed against all matter, for wisdom could not have willed so indiscriminately, or have assumed or divested itself of matter at will, for matter being a substantive can not be subject to annihilation, but must exist as an attribute of God, or as eternally associated with him, or not at all. Every ultimate principle of being must be of him, and co-extensive with his extent. Hence there can be no vacancies of these principles or attributes of God. One portion of the Eternal can not be invested and another divested of any principle of his being. The elements of things are in no otherwise to be understood but as the attributes of God. So what is comprehended by us as physical nature is by no means to be considered as the measure of any of these attributes, but simply as the sensible expressions of how far it has pleased Omnipotent Mind to exercise the energy attributable to him.

We certainly now perceive from the character of the great First Cause that there can be no vacuity, no intermissions among material substances; and even were it possible, these vacual interventions among material particles or bodies could not effect their separation, as there would then be nothing to restrain their mutual affinities from causing collapse.

The inferences derived from the observation of phenomenal facts are often found to be false and entirely different from the actual condition of things, so that substances being enlarged without any sensible additions is no proof of their enlargement being affected without a corresponding increase of matter affinitively associated therewith. We unquestionably do find the modifications of material conditions to be infinite, but we do not for a moment attribute this to any modification of matter in the abstract, for that is unquestionably immutable. Neither do we entertain the preposterous idea that blank vacuity is the modifier of material conditions, that alternations of something with nothing determine the relative bulk and gravity of substances, as the one or the other may happen to prevail. Nor can we agree in the supposition that sensible substances contain in their own constituent matter the forces which regulate the quantities of which they are respectively constructed, and imparts to them their quantities and characteristics, for in that case the forces would only be equal to their prevalent conditions which would be a finality, as the forces for their special construction could not again change them from what it had made them.

Now all these insuperable objections are obviated by the simple consideration that equal bulk contains equal quantity, whatever the conditions; as in this case no calculations have to be made about keeping the particles of matter this or that far apart, for we have it in perpetual contiguity in all substances, and under all circumstances alike, it only requires that this universally prevalent matter should be impressed with modified measures of gravitating energy to make it effect all the phenomena of nature, or different conditions of its own existence. Therefore it is not to the presence or absence of this or that much of the material quantity that we are to refer the character of sensible substances, but to the affinitive energy of their particles that we are to attribute their conditions. To this rule, whatever may be the nature of the substance, there can be no exception.

The molecular forms and their relative magnitudes, their affinitive energy, their associations, their combinations, and the compressive force to which they are subject, cause all the different substances, according to the circumstances of contiguity of kinds and of qualities, and vibratory excitements. Thus we see the density or ponderosity of substances has nothing to do with the quantity of matter employed in their construction; but it has much to do with our appreciation of them. The most affinitively impressed matter forms substances of which our senses have the most ready recognition. Our senses fail to recognize materiality only where the recognition could not add to our health or happiness.

We have manifold examples of the transitions of matter from the sensible to the insensible state, and we hope by this time we have made some progress in developing the general process by which nature effects these metamorphoses, whether sensible or insensible. In the transition of sensible to insensible substances we have seen that the particles of the sensible body, under certain excitements, become sufficiently separated to associate themselves with the insensible atmosphere in which they are enveloped, and to such an extent that they are upborne and rendered inappreciable by our faculties. We can often know the precise period when our senses fail to recognize the presence of matter thus changing.

Substances cease to be appreciable to the sense of sight when they no longer interrupt or reflect the rays of light. Now we do know there are substances, none the less existent, though neither conditioned for the interruption or reflection of luminous excitement. When sensible matter is so associated with insensible as to be so readily displaced as to produce no effect on the sense of feeling, that does not prove the termination of the matter, but of the inefficiency of the sense of touch.

When sensible matter is so separated, and in that condition which admits of no chemical metamorphosis when brought in contiguity with our organs of taste or smell, it will be altogether unable to excite either of these organs into any sense of its existence, for these organs can not be excited by the simple presence of a passive and perfectly quiescent fluid which would impart no action to them, being under no excitement itself. Thus we perceive the limited extent to which our sensitive tests are applicable to matter or material action, as indicators of the presence of either, but much more particularly when in the most passive state. Still no one will question the existence of very considerable quantities of some sort of matter beyond this very narrow limit, and if such be admitted, even to *any extent*, that proves the possibility that it may be so to *all extent.*

Beyond the point where our senses fail to realize the existence of matter, we can still, by the aid of chemical tests, detect its presence and activity. And by artificial means we may so improve the microscopic powers of vision as to be made conscious of organic forms and material fabrics, of which our unassisted organs never gave us the slightest idea.

This goes far to sanction the idea that the material principle, in some of its conditions and modes of action, may be continuously and contiguously extended to infinity, for we can no longer regard our sensitive appreciation of it as any criterion of its quantity, conduct, or condition. Seeing that organic forms endowed with vital functions are the result of its molecular arrangements and conditions, even on the very verge of microscopic vision, is at least very conclusive of its existence far beyond the verge of unassisted sight. As chemical proofs of the presence of matter can only be obtained by the affinitive activity of its forms, so it must be with the organic construction of microscopic monads, for even in this sphere of organic being matter must be equally active. We have but one sense, namely, touch, by which we can be made aware of the presence or condition of matter at all, save when the impression is induced by the motion or excitement of its molecules.

Activity, therefore, is as much a proof of the prevalence of matter as any that can present itself. What, then, shall we say of the physical excitement by which a sense of the most distant objects in the heavens is affected? How could the luminous pulsations from them to us, which are said to be seventy thousand to the inch, pass over an interval, even to the extent of one of these, without being extinguished or lost in the chasm?

In this proposition of the universal prevalence of matter we find no necessity for the contemplation either of any peculiar energy, or the peculiar exercise of energy for the generation of the many different phenomena observable in nature. What we have to observe is the different conditions matter would assume under the uniform action of that energy with which its atoms have been impressed, graduated in the requisite degree, together with the circumstances consequent from the common affinitive action of all with all. We have found that by the recognition of these principles, nature unfolds herself before us beautifully and sublimely; and though we may not always be able to trace the precise process in every particular of its minutiæ, we certainly can see enough to inspire the utmost confidence that the great problem of inorganic nature in all its details is clearly solvable by this system of investigation. Yet while we may thus readily comprehend the general scheme by which nature conducts her operations, it is only by inference and analogy, conducted with the most rigorous regard to first principles, that we can acquire any thing like a proper conception of the subtile processes practiced in this great ocean of insensible matter, among rudimental forms in their affinitive arrangements and erections into sensible substances. This being the grand reservoir in which all active phenomena have their root, and the great laboratory in which all chemical processes, combinations, and conditions are effected, its conditions and capabilities therefore can not be too well considered or understood. And though we have no physical sense that comprehends its matter or its mode of action, we can realize its nature and principles of action by induction, and by observing the effect it has upon our organs of sense, and on other substances; in the excitement of light and heat, and by the character of the sensible substances therefrom evolved.

By deduction, we have already defined its nature to be perfectly suitable for effectuating all the active phenomena in nature. Its elasticity, and impact, and the comparatively feeble force of its native affinities, with its susceptibilities of excitement, make it pulsate upon our organs the sense of light of heat, and of electric action. Of light, by oscillating that part of its matter immediately at its molecular junctions, or, in other words, intermediate of its molecular center.

Of heat, by the pulsation of undulous wavelets in the constituent molecules themselves. Light generates heat because of its reflection from our earth's sensible surface, being the most particularly conducive to its agitation. The matter of the constituent molecules of this excitable envelope are so affinitively bound by the most effective of its own and other material molecules, that the luminous oscillations intermediate of forms effect among the forms themselves, undulating action of heat exciting quality. Heat will, on its own part, excite light, when its undulating pulsations are so condensed, acute, or compacted together as to be of that measure and rate at which oscillation excites vision. The measure of oscillations from which light is elicited is of a very high order, and definable within a comparatively narrow limit to which computation assigns about seventy thousand to the inch; that is, the oscillation does not traverse more than the seventy thousandth part of an inch. The undulous pulsations that excite the sensations of heat are of every intermediate order, ranging from eighty to perhaps almost eighty thousand to the inch. We find heat elicited from the lowest sound-producing vibrations, as evinced by the excited action of frictional surfaces, to a sympathetic response to the highest luminous excitation.

By the association of sensible matter with that of this vibratory envelope, most energetically affected at and near our earth's surface, the oscillatory pencils of light are unable to operate in it, without inducing undulous or heat-inducing action by the agitation of its constituent tension into a sympathetic response; and as there are at the earth's surface the most considerable of this associated combination of these fluids, the result is the rapid diminution of the calorific ray of excitement upward, as the medium becomes progressively less susceptible of the propagation of this form of action by its rarefaction. We thus deduce from the effect of gravity, that the vibratory envelope must be best qualified at and near our earth's surface for calorific and other excitements essential to the condition of things thereon; and here, where calorific excitement is indispensable, we find it vibrates that action with facility. Here, too, the oscillating pencils of light are of that character and consistency which best affect sensible substances, and to which our organs of vision are specially and particularly adapted. Indeed, as we have already observed, could we ascend to any considerable height above this solid surface, we should find it fail to effect in us a sense of the sun's light, so that the nearer we approach that luminous body the less should we be affected by his rays, the medium of their transmission becoming less and less qualified to effect our organs of vision, until our sight of sun and stars became extinguished by our being beyond the conditions which could excite them into a sense of such bodies. And this would be long before we reached the verge of this earth's matter effective in fabricating substances; for, as we have heretofore observed, every condition of affective matter must have assumed form by its own affinitive impulse.

It will doubtless have been perceived that we hold the idea of bodies being self-luminous to be a positive absurdity or physical contradiction, because without action whatever might otherwise be the condition of the substance there could not be luminous excitement, for no substance could cause its own action. And any substance, to be even susceptible of such excitement, must have such energy of character as would totally preclude the possibility of self-action; for no energy of action could be imparted to matter without such matter were effectively located in some affinitively constituted substance, the disturbance of which in all cases is really what constitutes action. Perfectly passive matter could not possibly affect the impassive in any other way than we find luminous pencils do when put in motion in the manner as already deduced. We certainly see they have forces sufficient by their infinite repetition and accumulation to excite to great activity the affinitive powers of even sensible substances, but it certainly would be equally absurd to suppose that even such a force or action was self-perpetuating.

Force is only known by its effects, and every effect must serve to exhaust such force, on the principle of force and motion being equal. What, therefore, could compensate for such continued exhaustion of the sun's energy in keeping the luminous matter of the planets in continual motion? for such can not possibly be effected without constant force. As there is in nature no source of power save that found in the affinity of atoms, it necessarily follows that all force must be derived from this. How, then, can the matter of the sun perpetuate its own action, while the energy of planetary matter has to be constantly excited from its reduction to rest or affinitive quiescence? There is certainly nothing to justify the idea that the fundamental laws of physics should be different for different systems, or for the different members of systems. There is in nature, as we have seen, but one possible source of continuous power from which to infer the perpetual luminosity of the matter on the solar disk, or the action of matter in any manner, which is simply a reflex of the action induced on the material envelopes of planetary bodies by their motions among metaphysical matter in making their circuit round the sun, and which, agreeable to the character of the gravitating power, is the only activity that can know no termination, the inherent affinities of all else being constantly exercised to counteract the disturbances of rest caused by these interminable motions as the resultant of the combination of gravitating forces acting upon them from all parts of the heavens. So admirably do the phenomenal circumstances in physical nature flow from and unfold each other in this system of pursuing physical inquiry, that we have here the most conclusive evidence of a very important fact presenting itself unsought for, and which could not have been otherwise demonstrated; namely, that every self-luminous body, or rather those that are usually supposed to be such, within the immeasurable range of vision, is, like our sun, surrounded by tributary and motion-contributing masses of secondary character such as our planets, whose motions elicit light from their sense-encircling and exciting atmosphere.

The gravitating affinity of atoms, of which we so often remind the reader, being the sole source of power which compels the perpetual motion of the planets round their primaries, and constitutes them the main-spring or balance-wheels of motion from which all activity is derived, they being the only motal power that is thus necessarily perpetual, must as necessarily be the only means by which perpetual life and activity is imparted to the universe. As an evidence that the medium effecting light and heat are everywhere prevalent with us, and that neither of them are real products of the sun or any other self-luminous body, is that we can excite them at pleasure. This we could not do were there any substance or vacuum from which this medium was excluded, or in which it could not be excited into light or heat producing action. There are but two ways, as we have already seen, by which a fluid conditioned for such action could pulsate the principles of light, heat, or electricity, the one by oscillating its atoms, the other by undulating its forms. Now, there are certainly many reasons for rejecting the idea that luminous excitements and undulous action are in any other sense identical than at times in the measure of their pulsations. The marks of dissimilitude between the effects of light and heat upon sensible bodies are so prominent and conspicuous as to leave no question of their being effected by two very different modes of conduct, into which this same common medium is susceptible of being excited.

Although the pencils of vision are generative of calorific pulsation, unlike that action it enlarges no substance by causing its expansion. It induces no direct decomposition or recomposition as undulating impulsions do, although it is their primary cause, being the only excitable action by which all other action is generated. It is not continuous in its effect as calorific pulsations are after the exciting cause has ceased.

The effect it is found to produce upon the surfaces of substances in modifying their manner of reflecting its own oscillatory pencils, and some other delicate conditions of a chemical character, it may or may not be the direct means of effecting; for that is most probably consequent from the electric undula it induces, or it may be from some modified measure of its own oscillations insufficient for the excitement of light. But we have not a single example of its being the immediate agent in effecting any of the more forcible phenomena. On the other hand, we have abundant evidence constantly before us that the calorific pulsations are not so restricted in their range of action, for we find them associated in, and indeed effecting, the principal and most conspicuous part in almost every phenomenon of nature.

Electric action, although no less important in its effects, and of a far more diffuse and universal character, is much less conspicuous in its operations, doing its delicate office in the departments of nature most removed from our perception, the matter in which it acts being so affinitively refined as to admit of the operations of its nicely delicate undulations, essential in the most refined parts of formative processes. While this action is coextensively propagatable in the same medium with caloric, it does not follow that they are propagatable with equal facility; for this substance, as we must perceive, when best conditioned for the one, is least calculated to pulsate the other; for when our common atmosphere forms part of this pulsatory medium, it is the best conditioned for calorific excitement, and the least susceptible of electric action. The effect consequent from the excitement of this all-pervasive fluid in some form of its affinitive condition, and under certain modifications of its action, are truly infinite; for, in a very great measure, by this action it is that organic nature is agitated into being in all its forms and phases. By its activity the affinity of atoms has been enabled to form the chemical and mineral treasures of the earth. Its activity agitated the ultimate molecules to their respective places in the substantive assimilations of matter. By the matter of this fluid, and its mode of action, all sensible substances may be more or less expanded or exploded, decomposed, recomposed, or transformed into something totally different from what they were, as contiguous affinities might determine.

Now in what but this invisible medium could this infinitely prolific action be pulsated? There seems no substance from which it is excluded, no chasm it does not span, or interstice it does not fill; it is excitable in all, to all, and through all. We surely can not ask better proof of its universal presence and physical effectivity than what we have in its sensible effects. Nor can we so far insult the good sense of the age, as to suppose the hypothesis of corpuscular projections is any longer entertained, or will still be contended for, as the cause of light, nor will we expect to see undulous pulsations any more insisted on now that a way is opened up that is so evident. Or that these excitements are caused by an affection of the constituent molecules of sensible substances themselves, whose forces are only effective of their quiescence. We can not conceive how the economy of nature could be conserved by substances having in themselves revolutionary powers that could agitate for their own destruction. We are equally at a loss to comprehend the rationale of sensible substances agitating their own action beyond their own surfaces. Excitement can not be communicated from object to object only by some suitable intermediate medium.. All this clearly indicates not only the necessity for, but the existence of, that medium of measureless excitability which we have found to envelop our earth, and to invade every substance making up its mass, and of which light, heat, and electricity, in all their grades and degrees, are but the sensible expressions. The effect of these excitements upon sensible substances, although originating in this one source of action, are certainly so different as to prove that the pulsations for each can not be of the same character; for identical action would necessarily beget analogous effect, so that if heat is consequent from undulous excitation, the sense of light must be the effect of some other form of action; and while the pulsatory expressions of light and heat are thus so very different in character, they are at the same time found to be generative of each other, a circumstance to be accounted for only by the concatenations before noticed.

There are no artificial means of mechanical construction by which we can now or ever expect directly to induce luminous impulsions, because we have nothing which will immediately act upon the oscillatory pencils with the required intensity but by first inducing undulous pulsation, and when that is in sufficient degree the luminous pulsations immediately follow. But they are not for one instant continuous after the exciting cause has ceased. This certainly would not be so were they undulations of any elastic fluid, for that could not instantaneously cease its action, at least the calorific pulsations are only found to be progressively extinguishable. Time is required both for the generation of calorific action and its restoration to quiescence, just in the order undulous vibrations would pulsate in an elastic fluid susceptible of such action.

We can very readily excite this common medium into heat-giving undula, by frictionally vibrating surfaces, because the high compression causes such contiguity with them as subjects it to sympathetic action. The usual vibratory pulsations of heat can be rendered active by ignition and by percussive condensation; but this last is no generation of the undula, but simply forcing them to occupy a much narrower sphere of action. By either process excitement of a high order can be induced, and when such is the case the undulous pulsations instantly induce the oscillatory pencils of light, which having their source at the very focus of calorific excitement, become the luminous expression of that action, and the reason they indicate it at such vast distances beyond where the heat-generating impulsions extend, is because the rays of light pulsate with equal vigor whatever may be the distance; for they are ever the same from their focus to infinity, or till some resisting substance of an elastic character reciprocates or reflects these impulsions back. These oscillatory pencils can only cease their luminous effect when they become so divergent by distance as not to excite our organs of vision.

Why this oscillatory excitement is so continuous, and of such equal vigor throughout, is because it is induced among the least affected matter of the constituent molecules of the vibratory substance; for that being intermediate of their centers must be least affected by their affinities, the forces being perfectly equalized in opposite directions; the lines of least resistance, therefore, being thus intermediate of forms, will necessarily be the paths of the oscillatory pencils.

Now atom being in contiguity with atom eternally, this atomic ray must be continuous to some body perpendicular to itself which could reflect imparted impulsions back, as atoms can not penetrate each other, or pass out of the way, all parallel pencils being equal, a visual impulsion imparted to an atomic pencil at the farthest distant star will necessarily and instantly impinge upon our globe's utmost verge the full force of the initial impulsion. Thus light is reciprocated from body to body, however remote from each other, and all in the same space of time, because the only retardation must be in those mediums of effective matter by which these bodies are enveloped. Whatever, therefore, may be the distance between envelope and envelope, the time must be instantaneous, as the intermediate metaphysical and infinitely passive matter can impede nothing, or rather has nothing by which it can be impeded.

Hence the possibility by which light is almost instantly projected outward; the only opposition to the oscillation of its pencils being in the deep and compressively condensed envelopes of bodies from whose surfaces it is reflected, and those into which it penetrates. This opposition or resistance to the generation of luminous pulsations is the only reason that measurable time is occupied in the pencils being propagated across the diameter of the earth's orbit. It is not thus with the undulous pulsations of heat, for the affinitive quiescence of these vibratory substances, excitable though they be, must in a great measure be opposed to the propagation of the undulous agitation of their molecules, and must extinguish them within very limited range of both time and space. We have such constantly repeated examples of the sympathetic association of these vibratory actions from which the sensations of light and heat are derived, as would certainly appear to indicate their source to be the same, and to render it surprising that its nature and mode of action should have remained so long a mystery, for it is a truly surprising circumstance that the idea has not suggested itself on observing the facts, we being in the constant habit of availing ourselves of its instrumentality whenever it is desirable to have the effect of its action in our domestic transactions in the excitation of our organs of sense or of any other substances.

We may at the same time be immediately satisfied that it is not by the fuel on our fires, nor the lamps on our tables, that our organs of sense are acted on, for they receive their excitement without being in contiguity with either; indeed, so much the reverse, we are compelled to be constantly on our guard that we may keep separated from them by a considerable interval.

The fuel and the lamp are only to be considered as the objects to whose molecular action a medium common to and connecting all responds and acts alike upon our organs of sense and on all surrounding substances, and even so acting on the special objects by which it is generated as to cause their total but progressive consumption. These excitements, it would be absurd to suppose, could be propagated except in and by matter, for in its absence all action would be impossible, either as pulsations of undula or projections of pencils. Our common atmosphere so evidently impedes this action, that it can by no means be considered as the vehicle of such active propagation, and these excitements are equally inducible in space vacated of that substance. These pulsatory actions, therefore, being at all times and in every thing inducible, when proper means are applied, must, we should say, be the best possible proof that the sensations of both light and heat are affected by the action of one and the same all-prevalent medium. The common atmosphere being affinitively associated with this excitable substance while offering little or no impediment to the pulsatory passage of light (for reasons heretofore given), by thus rendering it more stubborn very much disqualifies it for responding to the undulous pulsations of heat; so that the passage of heat is more by transmission in the less effective matter by which the constituent molecules of the atmosphere are expanded, than by diffuse propagation in the medium itself. Indeed, so greatly does the atmosphere impede the passage of this pulsatory action, that in the interior of substances from which atmospheric association is excluded, excitation is condensable to a very high degree, by being generated faster than the atmosphere will carry it off. Of this tardy propagating power of the atmosphere we unconsciously avail ourselves whenever we wish to get up a higher order of excitement than is generally prevalent, of which the combustion of the fuel in our grates is a familiar example. The ignition of the fuel is caused, not by an immediate vibration of the solid constituents of the substances into a separation of particles, but by so vibrating the common medium in contiguity with a portion of their constituent forms, as to cause their disintegration from the common mass; and they then instantly form other affinitive associations, and with such molecular activity as further excites the common medium under the pressure of which the process is conducted.

Thus we perceive that this molecular activity of combustible substances, by being excited into activity through the action of this common medium, is in its turn reciprocally generative in that same medium of the very excitement by which its own action was induced; and although very much of this exitement is constantly appropriated by the affinitively expanding molecules, the very action of this affinitive expansion causes an accumulation of this excitement exceeding the constant demand. This insensible but excitable ocean, in which all things are immersed, does not only agitate sensible substances so as to cause their dissolution, but it likewise furnishes the material with which their constituent matter associates itself when expanding into that gaseous insensibility which follows their reduction by either decomposition or combustion. Of this expansion by association of the sensible with the insensible, and the excitement caused by such metamorphoses, we have many examples; and none more particularly and frequently present themselves to our notice than in the heating and illuminating of our dwellings; in these particular operations we have the advantage of this universal agent by which in reality these processes are affected without the world ever being aware of it. It does seem very surprising that while it excites all life and activity, it should never have excited in the mind of man more than a bare suspicion of its own existence. It has existed since chemical and organic activity began; it has been the cause of every thing else but the conception of its own being and character. Every phenomenon in nature proclaims its presence and activity, but in cabalistic characters to which there seems to have been no key. When, for instance, we contemplate the process of combustion, we must at once see that something more is required in that operation than the simple presence of the appreciable fuel and common atmosphere, for they can be present in their most combustible character to an infinity of time without affecting their own decompositions by any process. If they have not in themselves the matter or activity that can cause their own dissolutions at one time, they certainly would have not wherewith to induce it at another time. Without action and affinitive additions of matter how could they possibly expand into gaseous invisibility? Philosophy and science usually undertake to solve this problem by telling us of the intrusion of some supposed calorific fluid, or of the presence, or absence, or equipoise of the electric fluids, or some revolution in the polarity of the constituent molecules of substances.

Now, as they do not inform us on what principles these intrusive substances should be considered expansive, or present, or absent, *per se*, more than any other matter, we are at liberty to consider them in the same category with other substances occupying space by a very different system from that which either philosophy or science has suggested; and as the forms constituent of substances could not revolutionize their own polarities, nor have philosophers informed us by what process such is accomplished, we are equally at liberty to set aside this extraordinary assumption.

When we consider, with reference to substances, their different bulk under different conditions, and that steam is to water as seventeen hundred to one, we may certainly suppose that gaseous matter ascending from substances in process of combustion must be at least that much, and perhaps many times more, the bulk of the substances, than when in solidity. Now, in order to illustrate by a familiar example the process by which the expansions and transformations of substances are effected, let us consider that the fuel for our fires is mostly composed of that form or species of matter known as carbon, and as more or less affinitively associated with hydrogen, and that both, under favorable circumstances, have a strong affinity for oxygen. Let us observe the action induced by this affinity under the circumstances favorable to its development.

In the first place we will observe what takes place when carbon alone constitutes the bulk of the substance subjected to the process of combustion. Fires made of the best prepared charcoal will afford us the best opportunity for observation. To induce combustion in this case we have to excite to igneous action, not the coal, but the common excitable medium immediately in connection with it. The consequence of this excitation among the molecules of concentrated carbon, of which this excitable substance is invasive, will be, that those most exposed to its action will be agitated and liberated, when they will on the instant affinitively associate themselves, not only with the oxygen of the atmosphere, but with the insensible substance whose action agitates the particles of carbon into such a separation as renders them free for association and enlargement. If they associated themselves only with the oxygen of the atmosphere, there would be no formation of carbonic acid gas, for such would require supplies of matter equal to the enlargement of the volume assumed by the gas. Now a large volume of gas is constantly evolving from this combustion of carbon, without any very rapid diminution of bulk. The molecular activity that takes place in the formation of these affinitive relations, by which substances are so enlarged, is of that character which can keep up the vibratory excitement in the vibrating substance sufficiently for the progressive but total disintegration of the whole mass of carbon, however extensive it may be. This constant and self-generating cause of excitement is usually more than equal to the exhaustion by the expanding molecules in the formation of gas, but the rarefaction of the atmosphere, by constantly absorbing and expanding, carries off the calorific excitement much after the manner of its absorption in the expansion of water into steam, though with this important difference, that in the formation of steam the excitement has to be got up in another quarter; while in combustion, not only the required excitement and supply for converting them into gas is involved and evolved by the same process, but there is at the same time generated a very great excess of what is usually called free caloric, that is, a quantity not required in sustaining the new relations which the exposed substances have assumed; and such is the character of the excitement which concentrates itself in and transforms by its effect the aqueous molecules in their affinitive relations into steam. And how otherwise is it possible to comprehend the resolution of substances by excitement into the occupancy of so much more space, as these gaseous expansions demand? There certainly is no sensible source from which such needful supplies can be derived, or substances of any sensible character in which excitement is at all times propagatable; therefore this must be by the susceptibility of some common medium to whose action substances in general are exposed and more or less responsive, and with whose matter, under certain circumstances of its excitement, they more or less affinitively associate.

The best proof we have of the prevalence and universal efficacy of this substance is the effect it has in phenomenal development, for there is not a motion among matter which it does not in some degree influence. The excitements that are so essentially *à priori* of all transformations and expansions of sensible substances, by being opposed to all the constituent forces that form their affinitive characteristics, can not possibly be supposed to have its source in the substances themselves.

It would, for instance, be very absurd to consider the carbonaceous substances or any other form of fuel as generating these high excitements *per se*, besides propagating them into other substances far beyond their own surfaces. The concentrated and cohesively located condition of their constituent particles would certainly preclude the possibility of undulous pulsation of that permanency we often see in substances, until they are agitated into a separation by an action and force that can not be of themselves. But when this molecular separation is once incited, the separating molecules instantly associate themselves with other matter, and the affinitive force of motion with which this is effected induces the further excitement of the elastic medium in which this molecular action is immersed. This process of combustion is more or less prolonged by the rapidly generating excitement being kept from accumulating by being carried off in the expanding gases and enlargements of atmospheric molecules; so that the molecules of the mass in general can not expand beyond the igneous state until the separated particles, already assuming the gaseous condition, have been satisfied with the quantity suitable to their expansion. As the calorific excitement in water can not be induced beyond what is indicated by 212°, so it is with most combustible substances, they being only excitable to certain degrees of temperature, while their separated particles are expanding into gas and absorbing the excess of excitement. It will be observed that different degrees of excitement are required to separate the molecular constituents of the several kinds of combustible substances. When they are of carbon only, combustion proceeds but slowly under ordinary circumstances, and at but a low red rate of ignition; the excitement generated thereby being but little more than the excitement appropriated by the gaseous expansion of the liberated molecules, there is therefore but little accumulation, hence no very rapid dissolution of the decomposing substance; and when this substance is excluded from the reception of the oxygen of the atmosphere, for which alone it seems to have an affinity, it may be excited up to a high degree of heat without suffering much in its own dissolution at all by having its molecules transformed into gaseous expansion.

But when hydrogen is to any very considerable extent a component of the fuel, the circumstances of the combustion are very considerably changed; for we find that hydrogen is rapidly liberated, and its resolution into gas affinitively affected at a temperature even below red heat. At this low rate of temperature, its relations are usually such as to reflect the pencils of light and render it visible as a cloudy vapor. In this state, quantities of it, during combustion, are often forcibly ejected from the substances in which it was concentrated. But this gaseous state of the hydrogen is still readily resolvable into further combustion by an elevation of temperature, as we perceive when it assumes the character of flame.

The excitement caused by this combustion of gas, from the molecular activity in its combinations with oxygen and other matter in aqueous composition, exhibits itself in a much more brilliant illumination than that induced by the combustion of carbon alone. Indeed, we have, by the combustion of substances, light from the dullest red to the most brilliant white. This is but a sensible indication of the obtuse or acute manner in which molecules are affecting their several orders of affinitive combination; that is to say, the order of molecular activity by which pulsation is imparted to the compressed medium common to and intermediate of all. When affinitive combinations are such as to effect the most obtuse pulsations, we have heat without light; and when the delicately acute pulsations are effected, we have the most brilliant exhibitions of light. The gradations from the lowest to the highest order of luminosity is measurable by so many pulsations in a given space; as for instance, suppose from sixty to eighty thousand to the inch. Through this supposed series we have the excitement of both heat and light in relative degree. Now there is every thing in this to indicate an excitable medium common to both orders of pulsation; and if we would, in view of this proposition, observe the flickering of flame in the combustion of hydrogen gas, we shall be satisfied that its action is in the midst of an insensible substance, into which it is resolving the gas, and by which the excitements of light and heat are radiated.

The recognition or admission of this common medium when properly considered and applied, with its vast pressure and vibrating susceptibility, and that persistency that can insinuate itself into every substance however seemingly solid, will solve the great problem of all the variable actions and conditions that matter ever effects or assumes in virtue of its own mutually affinitive forces.

When this medium is so associated as to include sensible matter, in the same proportion will its action be effective upon our organs of sense; but when it is associated with no sensible matter, it is *not* sensibly effective, however great the excitement, except when it is highly concentrated in isolated condition, as in the case of electricity, and then only by its effort to restore equilibrium, as already explained. The pulsation of its pencils in our sensible atmosphere is where it is so associated with such order of affinitive matter as to affect our organs of vision. Its pulsations of calorific excitement can only be effected by its affinitive admixture with matter, that when sufficiently concentrated becomes sensible, and where it can be reflected from the surfaces of solid substances.

There certainly can be no position in the earth's matter more favorable for the sensible effect of these actions, than where the sensible passes by gradation into the insensible; here the undulous pulsations of heat are the most forcibly reflected and propagated; but this force fails in its effect on ascending from the earth's surface, as its associations with insensible matter less and less prevail.

There, too, the pencils of light are most impressively propagatable, because the affinity of its matter must favor the effect upon our organs of vision. But it is otherwise with the most continuous and diffuse excitements of all, viz., electric action. This is most effectually propagatable in this insensible substance when least associated with sensible matter, and hence it is that metals and other substances that can not retain atmosphere in their texture are good conductors of the electrical excitement. Indeed, under this pressure, and the presence of its matter and modified action, are evolved all the infinite phenomena in nature. The degrees of gravitating affinity that affect the molecules of matter thus restricted in their formative capacity, cause the different conditions of sensible substances, whether aeriform, fluid, liquid, solid, hard, soft, flexible, tenacious, fragile, elastic, or of any other character, grade, or condition, either permanent or in transition. We have seen how it is applicable to and explanatory of the usual forms of combustion and affinitive construction.

We have observed how concentrated hydrogen, under the excitement of this common medium, resolves itself into gas by the enlargement of its constituent forms. We have but to contemplate the process from the lowest order of combustion to the highest grade of explosive expansion, which may be found in the most readily explosive mixtures; the operative process is the same for all, except in the degree of their activity. When excitement is introduced or germinated in these explosive substances by the ignition of but a single grain, the component molecules, thus liberated from solidity, and some portion of the compressive impact in the relaxed wavelets of excitation, instantly satisfy their affinities for the insensible matter with which they surround themselves; and this molecular action induces such excitation in the invasive medium as almost instantly to explode the whole mass of this concentrated gas, at the same time as it will be observed that this molecular activity excites such an abundance of calorific action, that there is much of it evolved in a sensible form besides what is essential in sustaining the expanded gas.

Now, in the combustion of most substances, atmospheric air is essential to produce that excitement which is necessary for the continuance of combustion, the constituent matter of the combustible substances usually having such an affinity for oxygen as to associate therewith in the formation of gas, this new substance enlarging itself by the insensible quantity. With gunpowder and other kindred compounds the difference is, their molecules affinitively associate themselves with the insensible matter without the intermedium of the oxygen of the atmosphere, and this even more effectively by the atmosphere's being excluded from the instruments in which it is usually ignited.

This affinitive formation of the exploded and expanded gas being precluded from passing out where the insensible matter by which it is expanded came in, the expansive force necessarily operates against the substance by which it is sought to be confined, and will make its exit in the way where least resisted. This is analogous to what takes place in the formation of steam, for we find that it is not essential to the formation of this substance that air should be admitted into the generating vessel, for the aqueous molecules readily enlarge themselves when they have sufficient excitement, and altogether without its presence. Under a certain excitement induced by extraneous means, the aqueous particles satisfy their affinity for the molecules of the insensible medium, and this affinitive association precludes the passage of this new compound through the metal of the steam generator, and hence it can be condensed or compacted until it has force sufficient to explode the boiler. We must be fully sensible that without excitement all nature would necessarily remain in inflexible frigidity; and we must be equally satisfied that the cause of these excitements can not be in the sensible substances themselves, for their structural characteristics totally disqualify them for any such delicate action, except as it is induced. This, therefore, is but another proof that there must be an excitement-inducing medium common to all; and we have otherwise fully demonstrated the prevalence of such a fluid, and its perfect susceptibility of responding to all the requirements of nature, as far as such a fluid can be effective.

All this being so, it is certainly highly essential that the nature of this medium should be well understood. Its excitement into such miniature modifications of its highly compressive tension may not at first sight seem very compatible with the unqualified proposition we make, of equal quantities of matter for equal spaces, even to the nicety of an atom; but when we take into consideration and can fully realize the fact of gradation, we must be satisfied that all matter is not alike physically conditioned in its affinitive forces; the gradation running through an infinity of degrees expresses itself in every variety of condition, the most energetic molecules forming the most sensible substances, and the least inergetic the most insensible substances or gases, which penetrate, pervade, or envelop those of the most positive character.

From the most minute sphericle of all physical matter to the most massive aggregate of such the same general order of formation must prevail, for the gravitating affinity of fluid matter must construct it into forms in most respects very analogous.

The severality of the affinitive energy of these, and the circumstances under which combinations occur in the construction of substances, gives to them their chemical characteristics, and the most perfect forms of solidity will follow from the most perfect conditions of fluidity, crystallization taking place peculiar to the condition of the solidifying molecules, their particles being agitated into their places by the action of the medium in whose midst the process is conducted. We must consider the earth enveloped in an infinity of these forms, thus susceptible of chemical combinations, and which at its solid surface are so compressed by those that are above as readily to assume crystalline solidity under that and other favorable circumstances. Now the elasticity of tension (from which the susceptibility of this enveloping substance for excitement is consequent) can not be caused by matter occupying more or less room by the separation or condensation of its particles, for matter in the abstract is neither separable nor condensable. Therefore, as we have often remarked, the vibratory elasticity of such a substance can only consist in the affinitive displacements of its constituent molecules, crowding them together into alternating wavelets of reciprocating laxity and tension; such alternating displacements of this fluid's affinitive molecules and force of tension, and their effort at restoration, can be the only excitement of which it is susceptible.

With the molecules of these alternating wavelets of affinitively displaced matter, the constituents of other substances during combustion or decomposition form affinitive fellowship. When sensible matter thus affinitively forms a relation with the insensible matter of this vibrating medium, the formatory action not only excites a continuance of the vibratory displacements, but it instantly occupies them, thus forming a substance so affinitively constituted, that it can be confined or inclosed in other solid substances.

In this same manner the transformations into aeriform or more expanded conditions are effected in all substances, whether it be steam from water, gas from gunpowder, or the more insensible exhalations from the brilliant combustion of hydrogen gas. In thus contemplating the characteristics of the different grades of combustion or of decomposition, and their laws of activity, we find them all referable to but one order of circumstances variously modified. Affinitive action and efficient excitement being the only requisites in any such metamorphoses, all is molecular activity, either by effort to restore disturbed conditions, or a reciprocity of action in the construction of new, in which combustion causes excitement, and excitement causes combustion, they being thus reciprocally generative of each other.

We have no other alternative but to infer that the degrees of sensation known to us by the name of heat are caused by more or less of the undulous pulsations to a given space in a susceptible medium of some kind, and we conceive that we have fully demonstrated what that is. We find that a comparatively low rate of such excitement in this medium, and the common atmosphere with which it is associated, will produce the sensations of both sound and heat, and we must be equally aware that somewhere about the middle state from the highest to the lowest grade of calorific excitement, light of a low order is produced; therefore the different grades of luminosity must be proportioned to the condensed acuteness of the induced vibrations, the least vivid being induced by the fewest number of vibrations to the inch, and the most brilliant light being excited by the greatest number of the luminously induced pulsations. Now, what are we to infer from this gradation of luminous pulsations to a given space thus excited by a calorific action? Certainly nothing favorable to the idea that the pencils of light are decomposable, as is usually supposed; for in the scale of gradation through which its pulsations must pass, in their sympathetic accordance with this calorific excitement, we have no exhibition of any thing like the prismatic colors, which are assumed to be the visible expression of a certain number of graduated pulsations to the inch. How is it conceivable that in one and the same excitable medium there should be induced all the gradations of intensity by which calorific action is excited, and the pencils of light thereby elicited in all their degrees of intensity, without inducing the prismatic colors that are said severally to depend on so many pulsations to the inch?

It is certainly very evident that the intensifying progression of heat is caused by the different degrees of condensation in the calorific impulsions, but how would it be possible for these impulsions to induce in this same excitable medium the several orders of luminous pulsations that are said to be essential for the exhibition of the several prismatic colors, by whose combinations it is assumed that the exhibition of colorless light is induced?

If these several orders of luminous impulsion are essential to the exhibition of colorless light, they must be in combination in all its progressive degrees of intensity; and had it even been possible that they could have been excited in the severalities of intensity, or several number of pulsations to the same given space that are attributed to them, we can not possibly see how this compound ray could have been effected into its general action at any low rate, for the lowest grade or least number of pulsations to the inch at which this colorless light exhibits itself could have had none of the higher numbers in its composition, and therefore could not have been light at all, or at least could not have exhibited any but such as was equivalent to the lowest number, because not having the other orders that are assumed to be essential to its composition as colorless light; for before it could pulsate the highest constituent number, they would necessarily require to have been excited, and this, the highest component number inducing its special condition of color, could not be at the lowest rate of excitement in the scale of which light in its combination is said to be induced; and that number of luminous pulsations which are assumed to produce the color lowest in the scale would, agreeable to this rule, certainly be the only color exhibited when none of the pulsations were more than at its rate. We find the different prismatic colors equally divisible at whatever rate of intensity the luminous-exciting pulsations may be induced, and we can conceive of no other way by which the intensity of light can be generated but only by causing the condensation of a greater number of impulsions in the same given space. As the sensation of sound is produced in all its gradations by the progressive condensation of pulsations in a given space of our sensible atmosphere, so are the different sensations of heat induced by the progressive condensation of calorific pulsations in the insensible atmosphere; and as the luminous-exciting pulsations are elicited from them in all their grades of vividness, we must infer that this, too, is caused by a condensation of pulsations, as being essential to the generation of any given color. We can see nothing in all this reconcilable with the prevalent doctrine of colors and their cause, but altogether confirmatory of there being something radically wrong in the doctrine of colorless light being caused by a combination of luminous pencils, each pulsating its own special number of perturbations to the inch. At least the evidence from this quarter strengthens the conclusion to which we had otherwise come, that the cause of prismatic colors is to be sought for in some other system than that different colors are caused by the pulsatory components of any general combination of their graduated degree.

Chapter Nine.

Geological Structure of the Earth—Its Shape—Consolidation—Uniformity of Surface—Accessions of Matter—Comets—Depth of Rocks—Inequalities of Surface—Elevation of Matter—Motion of the Waters—Specific Gravity of Fluid Rock—Igneous Action.

HAVING thus far contemplated creation, and perceived the progressive development of much of her most important phenomena, we will now return to the consideration of the general principles by which the geological structure of our earth has assumed its present condition, and contemplate the quarter from whence the vast accumulation of matter that makes up her stratified rocks could have been derived; for we can not by any possibility accede to the idea of its having been derived from the disintegration of previously existing rocks.

We have heretofore noticed that this planet, when it first became a member of the solar system in which it now circulates, may not then have contained more matter than about two thirds of its present amount, and that such matter must have then been in a far less solid condition than it has acquired since, or it could not have assumed the oblate spherobial form that it now has, for in that case the portion of the mass most immediately in the plane of the equator would not have been so readily obedient to the modifying influences of centrifugal action. Were its configuration otherwise than in accordance with this modifying force,. the centrifugal action would certainly have heaped the polar seas upon the equatorial lands, and thus the polar regions would have been exposed to the atmosphere, while the equatorial would have been correspondingly submerged beneath the sea. This not being the order of things, we must conclude matter to have been in a condition to take its form from the centripetal and centrifugal forces, and we can easily account for the fluid, semifluid, or obedient disposition of the earth's matter at this time accommodating itself to a rotation round its own center, without the necessity of supposing it in a molten condition by heat.

This all-prevalent hypothesis of igneous fluidity of the earth's primary matter, if it does not embarrass inquiry, can at least be dispensed with, without any inconvenience to the legitimate rules of physical research. That system must be an unsound and gratuitous one which assigns heat as the cause of phenomena, and is yet totally unacquainted with its intrinsic character, and consequently unable to account for all the peculiarities of its conduct. The very idea of igneous fluidity seems to imply that nature had been under the necessity of reducing matter from some obstinate state of solidity that it had previously been in.

But little consideration is required to perceive that solidity is not a free or first condition of any matter, but forced and of secondary character, fluidity being the direct effect of atomic energy when unoperated upon by the pressure of impact; but this energy of atoms, by causing material accumulations of vast magnitude, must necessarily have imposed pressure in progressive order upon all below, which ultimately reduced much of it to a solid condition, as we see. But this solidifying effect of pressure we may perceive had not produced its present stubborn results at the time our earth first began its revolutions round the sun. When she had concentrated about two thirds of this present sensible quantity, it is possible, as we shall see, that her accompanying insensible envelope may not have been equal to one third of what it is at the present time, in which case the pressure would have been proportionally less qualified to produce solidity, so the exterior mass of the earth's present solid matter may have remained semifluid long ages after she commenced her circulations round the sun. Consolidation, as the consequence of compressive impact and gravitating affinity, would necessarily begin at the center of any aggregating mass, and progress outward in proportion to the constantly accumulating quantity and the molecular energy of its matter, under the incumbent accumulation of pressure by which it was surrounded; so we see that by this the exterior of the mass may have remained obedient to the molding influence of its formative forces by centrifugal rotation, long after the center had been too far solidified to yield in obedience thereto.

The earth must have been sufficiently fluid to have assumed its present shape before the matter for the granite formation was deposited, for at that period, when the granitic quantity was in process of contribution (at least so far as is subject to inspection), both the earth's matter and the accessions it was then receiving from external space, must have had so much consistency as to prevent their blending down into one common liquid plane; for, as we before stated, were the granitic surface denuded of all matter now superimposed thereon, such surface would present the most extreme irregularity. Still, though this may be considered as positive evidence of the *absence* of fluidity among such matter at this time, it as positively proves that fluidity *had previously existed.*

The bases of the granitic formations are blended with the general mass on which they rest, and there is a crystalline connection of all with all which proves that some imperfect order of fluidity must, at that period, have prevailed, or the matter of this rock could not have been in that state susceptible of such crystalline solidity as has obtained.

When the consolidating matter of our earth, and the nucleuses of those substances by which she has been aggregated, become so far solid as to forbid their spreading freely out into a uniform surface, the irregularities we now find would commence and become more and more prominent at every subsequent accession. So long as this uniformity of surface prevailed by the flowing down of the coalescing matter, there must have been perfect coincidence in the earth's planes of revolution round the sun, and her necessarily resultant rotation round her own axis. Whatever angle these planes of motion may now have to each other, there must have been a time. and that at a comparatively late period of the earth's formation, when the fluidity of matter must have been such as to have caused this coincidence of motion, or rather to have permitted this coincidence which the laws of motion must have caused.

This fact, incontrovertible in its nature, will be found of great importance in the explanation of much geological phenomena, which is not otherwise to be accounted for. The facts of geological discovery ought long ago to have convinced the astronomical world of the great error of their doctrine, that the axis of the earth has always been in the same rotative position to her orbit as now. Did atronomers less stultify themselves on the perfection of their science, they would not so long have overlooked the many palpable evidences of error which geology furnishes in refutation of this erroneous proposition.

In contemplating the universal aggregation of energetic matter as a necessary consequence of the gravitating affinity of its atoms, from their interspersion through all space, we have found that secondary bodies in general, whether planets or satellites, must have accumulated more or less of their matter before they had assumed their relative positions in any system, and while yet in their isolated condition, or when they were making their way to their final destinations.

When we consider the almost incomprehensible sweep of each solar sphere's attractive affinity or force, we must necessarily conclude, that not only themselves, but their several members, must have assumed their relative positions in space long before the final ingathering of all the energetic matter situated within the confines of such immeasurable regions. These solar concentrating accumulations of power and systematic combinations of motion must have been felt everywhere within the sphere of their respective influences, the limit for this being on the intermediate line of separation where the forces of each are equal to each. The process of aggregation would still go on, and these several associate bodies continue to make accessions of material substances, while there remained any unappropriated matter in this vast solar space. Attraction has, or will ultimately determine, the coalescence of every species of energetic matter with one or other of the members of those systems within whose sphere of action its energy was originated.

The planets and satellites themselves are the only exceptions to this universal rule of concentrative coalescence, caused by the peculiar combinations of those forces which so resolve their paths of separation that they can by no possibility ever coalesce either with the sun or each other, while with all other substances they rigorously exact its fulfillment; so that we shall find that even the comets themselves will not have a perpetual immunity from the coalescing effect of this universal law, but must finally contribute all their matter to one or other of these associate bodies. It would seem that concentrating substances, such as the planets and their satellites, must have been either peculiarly circumstanced or of considerable magnitudes before they could have acquired momentum sufficient to make them to be such exceptions to this common rule as to swing clear of the attractive centers they encircle. Were it not a positive rule, that considerable momentum was a condition of constant motion, the planets and their satellites would now be surrounded by a multitude of miniature worlds revolving around them; and as we have no evidence that there are such bodies, we conclude that minor substances had not forces sufficient to make them exceptions to the general law of concentrating coalescence. Thus we see that all substances of less magnitude and density than the satellites have been absorbed either by their primaries or by the sun, or still remain subject to such absorption, except it be the asteroids; and they are perpetuated in their places for reasons heretofore explained.

Had the path of the earth, when descending from space, been at a much less angle from solar verticity, she must have impinged upon that body, and added in her own mass a small mountain to his enormous bulk. And had the moon's path been a little more perpendicular to our earth, such would have caused her coalition with us, and in that case the addition would have been something more than a mountain, unless she has very much increased her bulk since she assumed her present relative position, of which there is perhaps but little doubt.

All the exceptions to this general rule of concentrating coalescence are but the necessary consequences of the gravitating attractions of matter, and the compound effect of the momentum acquired by a body in its fall from a tangent to its orbit, as operated on by other exterior attractions, which keep them from any nearer approach to the gravitating center; and if the moving body had not sufficient magnitude and density to acquire the requisite momentum, the gravitating force of the concentrating mass within whose influence it had descended would necessarily be fatal to its perpetuity of motion, and this we find to have been the case with all bodies of less energy than the satellites.

Nothing in nature leads us to infer that all matter had been gathered in when the planets assumed their positions round the sun; but, on the contrary, we have evidence that vast quantities of matter must have been concentrated after they commenced their revolution; their own satellites (as a general rule) were not then concentrated, and in circulation round them. We infer this from the fact of all their paths being in one direction, a coincidence that could have been caused only by these bodies descending to their positions individually, so that the combined energies of all should thus determine the positions and motions of all, the first leading in the same direction with itself the succeeding one, and so on in succession. Had the planets acquired their satellites before making their descent into the central system, there could have been no cause for this coincidence in direction; and had the direction of either been originally different, it must have continued so, for the combined force of the associate members could not have effected a change in the direction of circular motion when once formed.

Thus, therefore, being satisfied of the satellites having been concentrated or brought into the solar system subsequently to the planets, we have every reason to conclude that vast quantities of matter aggregated in substances of every denomination of minor importance and magnitude must have been introduced and distributed among the several members of our system by their coalescence. Even at this day there are occasional indications that the aggregations are still incomplete and in process, for portions of what are usually considered as the nucleuses of small bodies attracted from space, are at times found to penetrate to the earth's solid surface before they are dissipated in passing through its envelope. These bodies are usually of cometic or etherealized matter, their nucleus being the only exception, and that could thus assume solidity; for had their matter been more energetically affected, they would sooner have sought coalescence with some concentrating mass. Since the earth has been inhabited, we have had nothing to fear from the coalition of any external body, as these are or would be dissipated in descending through the depths of her enveloping atmospheres, leaving intermingled therein the whole or greatest part of their matter in the ratio of its progressive density downward to her sensible surface, to which but small portions of the most energetic can ever arrive; but it is still sufficient to show how it was that our earth and all other masses were made up; for of such accession, only on a more extended scale, did she acquire both her solid nucleus and all the matter by which she is surrounded.

The permanent members of the solar system, or any other substances, could not by any possibility have originated their own matter; from *whence*, therefore, but from space could they have obtained it? And *how*, but by the progressive concentration and coalition of substance with substance, together with occasional contributions made by the common collectors and carriers (the comets) whose office it is to make periodical peregrinations into the remote regions of solar space and make collections of the feebly-affected matter there outlying, whose gravitating powers were insufficient to feel the influence of distant bodies in the solar association.

It has doubtless been observed that the smaller comets, whose periodic returns are most frequent, are decreasing in matter, owing to the tributary exactions imposed upon them by the central associations of power to which they are so often compelled to return and contribute a part of their matter; and being unable to acquire an equivalent in the exhausted fields that once furnished them, they will become sensibly less, and will continue this decrease in every periodic revolution until their own force can no longer preserve them from being merged in the masses to which they have been so long tributary.

From this we perceive the concentrating process and its contributions are still going on; and although the sensible nucleuses of the sun and planets may not have had any important additions since the introduction of our own race, yet their conditions no doubt require that they shall from time to time receive such accessions to their enveloping substances as comets bring from remote quarters.

When we consider the comprehensive Intelligence that caused matter to be energetically affected, we must necessarily conclude that every atom had its special destination to fulfill during all time, and that it was energetically affected with reference thereto.

Some of the cometic bodies have unquestionably solid nucleuses, and perhaps of no inconsiderable extent, which on their final coalescence with concentrative masses might at first view seem to argue danger; but when we reflect that their solidity is caused by the pressure of their own exterior enveloping matter, we see that as this matter is given off or contributed to planetary bodies the solidity of their nucleuses will disappear; we perceive, therefore, there need be no fears of injury from their collision.

It may be imagined that the solar and planetary bodies have long been complete in the aggregation of their matter, because there is no visible necessity for further acquisition, nor much evidence of their being made; but in the present system of inquiring into the phenomenal facts, causes, and characteristics of physical structure, we may perceive the necessity for the occasional influx of the feebly affected matter which the comets are commissioned to gather up and bring in from afar, as compensation for what may be appropriated by organic or other forms that are continually fabricating from such matter. As physical nature is but the reflex of Omnipotent Conception, there will remain nothing uncalled for in the process of development, and nothing unaccounted for in the eternal unity of its consummation, for in that conception the most infinitesimal or other imperfection could have found no place. With respect to the particular mission of cometic masses, we are not aware that mankind has even indulged a conjecture, there being nothing in the usual system of reasoning to indicate their office, or any thing in the usually assumed laws to make them essential.

But from our system of pursuing physics, we deduce a different order of things, that does not regard it to have been either essential or suitable for the planets that all this outspread matter should have been added to them at once; for in the earlier epochs of concentration most of it must have been in a nebulous or outspread condition, and not then required by concentrating bodies; but time and affini-

'tive circumstances by effecting progressive transformations and transpositions in the general adjustment of the earth's exterior, in the construction of the stratified members of her compound crust, of her oceans, her atmosphere, and her organic forms, would so appropriate from time to time from this great reservoir for the chemical department of nature as would enable her to carry on her various processes in formative effectivity.

Every chemist is aware that but little can be effected by matter in a state of solidity, therefore every chemical process, either in the interior or at the surface of the earth, must be affected by matter having energy and fluid freedom of action.

These numerous processes of physical nature would finally exhaust that form of matter by its appropriation, and from whence would have come the supply had there been no residue of such matter left out in the general aggregation? There must not only be some quarter or source from whence the earth has derived her chemical supplies (seeing she could not have originated them), and likewise almost the whole matter composing what is called the crust; for there is but little soundness or satisfaction in the usual assumption, that by rubbing down old rocks there was found material for the formation of the new. In the formation of the earth, and every other massive body, including her exterior and stratified rocks, the supplies must have been accumulated from without by the coalescence of concentrating matter upon their external surfaces; and this would continue till matter had attained its ultimate position in a relative point of view; and although this is not even yet entirely consummated, we have no evidence of any extensive acquisition having been made to the earth since that which caused the diluvial matter to be spread over the surface of its northern hemisphere.

But because the most of the sensibly affected matter had been gathered up in forming the planets in their solidity, such affords no proof that the lighter matter was all concentrated at the same time; large quantities of fluid matter might still be required in the forma-ive processes, and in affinitive association with the more effective atter in molecular formations, which the solar or secondary bodies ould not obtain from each other; nor could they generate it themselves. They would soon exhaust the intermediate spaces to such a degree as would require replenishment from some quarter; and being so far removed from this feebly affected matter as no longer to attract it to themselves, comets became necessary for its aggregation, or, rather, it aggregated itself into cometic bodies, that were commissioned by their powers to make periodical passages of certain duration into the remote regions of solar space, the better to procure these feebly affected supplies. Now these cometic collectors, whose paths are into the remote regions of space, are more than likely to return enlarged, and can thereby contribute portions of their most ineffective exteriors to our sun as they encircle him, or to our planets and satellites as they may happen to pass through their enveloping mediums. In this manner will all the comets be finally absorbed, and their individual identities wholly obliterated.

The final accomplishment of this aggregating process will bring the solar mass and its members to such conditions of sufficiency as will enable their chemical operations to go on by metamorphoses of matter belonging to and a part of themselves, without a necessity of any further supplies from remote quarters.

Should this system of cometic action and affinity for the ingathering of all outlaying matter be considered as deficient, chimerical, or speculative, we here observe that it is not only a necessary sequence of the order of process by which we are endeavoring to portray the progress of physical nature as it was and is, but we have further confirmation of the facts in the circumstance that few or none of the paths of the comets have ever been found in the plane of the ecliptic, and this is certainly significant of something more than mere chance. The paths of comets may be found in every possible position or direction except that which coincides with this great plane. This zone of the heavens swept by our planets and their satellites when in process of concentration to their present positions, and since then, must have been divested of all such matter as composes the comets, and hence no such bodies are found circulating in coincidence with this great plane.

Now that we have contemplated the aggregation of solar and secondary bodies, and demonstrated their enlargements to have been by a series of exterior accessions contributed by coalescing substances, and have followed the process so far as the reception of the matter conditioned for the formation of the granite, we will now endeavor to deduce the relative condition of that portion of our earth's exterior in which the facts of geological observation are comprised.

The geological facts only refer to that portion of the earth usually called her crust, and which is of penetrable depth, comprehending the whole stratified series of rocks and the face of the granite on which they rest. The average depth of this series of formation is variously estimated at from seven to ten miles; not that this has been ascertained by actual penetration of the earth to this depth, for that would be impracticable; but it is assumed that the primary positions of these stratified beds have been so changed by upheavals, as often to bring to the surface more or less the upturned edges of the whole series of strata, so as at times to expose for inspection all the rocks from the foundation granite to the most superior strata, and not only from seven to ten miles, which is assumed as the average, but it may be in some instances from seven to seventy miles.

Now, when geologists inform us of this envelopment of stratified rocks, which they thus average at from seven to ten miles, and at the same time say that the materials for their construction was obtained by the grinding down of previously existing rock, we certainly must come to a conclusion in view of this vast quantity, that they are calling for more than common sense will permit credulity to sanction.

In place, therefore, of this being considered as the detrital matter derived from the degradation of rocks already belonging to her surface, or by ejections from her interior, we must regard the materials for this general structure of stratified rocks as having been obtained in the same manner as the matter for the foundation rocks, and from external space in continuation of the great aggregating process by which all physical matter is accumulated round common centers.

We have already considered the aggregation of the earth up to its period of semi-fluidity, and its circulation in our solar system and her revolution on her own axis, and we find abundant evidence that all her exterior subject to geological investigation must have been accumulated subsequently. We readily perceive that the molecular constituents of masses then precipitated on the surface of the earth (at the time and termination of this granite formation) could not have obeyed the leveling process as effected by gravity, or we should find more uniformity of surface than the granite or even the strata exhibits. And there can be no question but the mass of the earth, and contributing bodies external thereto, by operating in molecular affinity of their own constituent matter, must, in the lapse of time, have become less and less able on coalescence to spread themselves out into a plane, until finally the earth's surface had assumed, by the accumulations of imperfectly fluid substances, the aspect it would now present, could we see the granite surface now divested of the matter thereon superimposed.

This surface is very irregular, as its exposed deflections fully testify; but while the irregularity is the best evidence that matter was not in a perfectly fluid state when the acquisitions were made, it indicates with no less certainty that its molecular constituents could not have been in cohesive attachment; for we find the alternating elevations and depressions of surface so blending as to indicate that matter must have been but in particles, and they must have originated in precipitated masses of matter of more or less magnitude, and whose forms must have been spherical before reaching the earth. The matter of these masses therefore must have been soft, and susceptible of blending down with a broad base on whatever substance they may rest, making the whole assume the aspect of irregular and sometimes very abrupt undulation.

From this we may infer that though the molecular character of matter in general had very much changed, it could not have been reduced to a predicament less qualified for crystallizing into granitic rock than the matter of such rock would have been if submitted to igneous fusion. Yet, strange to say, most physicists absurdly assert this fusion to have been the primary condition of the entire granite formation, and that this ponderable substance while thus fused was elevated by some force into mountainous flexures, and retained in such elevated positions during the long process of cooling down and crystallizing into permanent solidity; we say long, because such crystals could not have been formed on rapid cooling. They do not enlighten us as to *how* this was accomplished; and apart from the improbability of such high calorific action at this period, and the utter impossibility of thus sustaining the mountains till they crystallized, it could not have been essential to the reduction of matter that had never been otherwise than reduced, and which was still in a state of primary fluidity, and hence ready for molecular arrangement into such crystalline forms as its affinities should determine under the circumstances of the time.

Had all matter originated in crystals instead of progressing to this state, igneous fusion might have been indispensable had other conditions been required than such as were prevalent. But when the affinities of matter were for the first time forming it into crystals, it certainly could have required no reduction, but must have been in the best state for such formation. We have wondered that it never did occur to geologists that matter must have been fluid before it could have been solid, seeing that solidity is the secondary condition. It is certainly the most unnatural, far-fetched, and forced construction to infer that the crystallization of granitic rocks with their undulating irregularities of surface should be the result of igneous upheavals or of convulsive and extraordinary revolutions in the condition of matter from any force or cause whatever, particularly when nothing equal to it has ever presented itself or can be conceived of; all must be but simply the progressive effect of affinitive action operating and aggregating through untold ages. The system of nature is only to be regarded as a progressive unity, with nothing to upturn or revolutionize in all her infinitely extended economy, that can not be otherwise than right as ruled by the effect of constant affinities. Therefore it is difficult, if not altogether impossible, to perceive the sense, justice, or propriety of attributing to matter extraordinary action of any special, partial, final, revolutionary or other character which had not its root in the rudimental atoms, and as determining their phenomenal resolutions of whatever sort.

The fundamental principles or laws of nature, however simple may seem their powers, being incapable of modification or change, must be answerable for all phenomena, for had they not been equal to all things, the great scheme of creation could not have been equal to its own visible or material expression. Had special and miraculous interpositions been required at any period of physical progression, it would have proved the inadequacy of primary law and principle (as applied to matter), to develop the various phenomena of nature, and would have been an implied imperfection in the Wisdom that willed it so; for if such special interposition is admitted, we must likewise admit imperfection in the originating Power, and a consequent implication of inability. We know the reverse is an essential characteristic of that Power whose perfection consists in such wisdom of conception as could involve no inefficiency in the fundamental agencies by which this scheme of creation was to be carried out. The means and ends being measured by the same volition of Infinite will, must have been in the strictest sense equal to each other; and even were it otherwise, it would in that case be folly to undertake to reason on the relations of things; for how could we know what was attributable to the inherent energy of matter, and what to the especial and miraculous interposition of Providence.

But while we thus consider the phenomenal characteristics of nature and their cause to be in determined and inseparable relation, having their origin in the primary impression of atoms, this by no means implies that they are in any means isolated from or independent of that Power by whom this scheme was conceived and for which these impressions were made. The creative Power and his principles of action are to be considered as one and inseparable, the physical series in all its relations being but its recorded expression; therefore there could be no necessity for any rule in special reservation to apply on suitable occasions or in case of casualty, or to co-operate in contingencies that could never occur.

We can readily realize that Infinite Wisdom and Power are the source of all instrumentality in carrying out the great scheme of the creation in obedience to his omnipotent will, but we can not conceive how the common forces of nature could have elevated and depressed the molten matter of rocks in the manner that now characterizes the granitic profile, and more particularly to have sustained it in such position until it crystallized into solidity.

Neither can we perceive the possibility by which mountains of such matter could be elevated by the special and direct volitionary effort of that will without the instrumentality of means, nor how modifications could have been made in the existing forces, imparting to them special and extraordinary powers, compatible with the immutability of first principles and their Omnipotent Originator.

We can not conceive that there is either in Nature or Providence any power equal to the elevation of such vast portions of our earth's surface from the depths of the sea, as is assumed by geologists to have been done. To what, then, are we to attribute the extraordinary upheavals and downsettlings of which we hear so much in hypothetical geology, in barefaced violation of the fundamental force of gravity, which in such cases would be any thing but inconsiderable? Information on this point we find to be of the most meager description. And even if it were possible that such ponderous matter could have been so elevated and sustained in such position until by solidifying it could have supported itself, the forces that could have effected it must have been of a different order of action and intensity of pressure from any that now prevail. What, therefore, has now become of this extraordinary order of power? If this assumed upheaving and convulsing force (by which geologists undertake to account for so much) has any foundation in fact or philosophy, it must be susceptible of being satisfactorily accounted for, so as in some measure to satisfy us respecting its nature and order of action; and without this previous explanation we can not perceive on what grounds geologists can so boldly build up their hypothetical systems of upheavals and depressions, which they so incessantly insist have paroxysmally effected the most important phenomena of the earth's surface.

The common center of gravity to which all her matter so manifestly tends, is certainly a very decided obstacle to be encountered and overcome by some force that yet remains to be accounted for before the system that sets itself up in opposition to this permanent and uncompromising principle of gravitating action can be calculated on with any possible degree of confidence. Now, where do we find the cultivators or inquirers into geological dynamics either sensibly or satisfactorily accounting for the paroxysmal characteristics of those prodigious powers with which their favorite forces must have been invested before they could have made the earth's surface oscillate so often and so easily to and from the depths of the sea as their theoretical notions and speculations imply. Igneous action, volcanic action, and internal action are the terms used by geologists to signify the forces that have effected all these assumed paroxysmal or prolonged upturning of strata, of which they find so many seeming records in the geological archives of the earth, as typified by the contortions of her rocks, the upturning of her stratified beds, the upheaving of her continents, mountains, and islands from the bottom of the ocean, together with the formation of all the prominent features of her projecting profile. Now for all this we can not conceive it otherwise than absurd to consider that there is any potency in the abstract terms themselves, which thus, undefined, can be significant of nothing, or at least that which is such as could give the present geological expressions to the earth's surface; for in place of deducing the facts of upheaval from well-defined forces that are known to be sufficient to produce them, they take the phenomena themselves as the sole basis of the whole hypothesis; and, in consequence, the forces which could have effected these phenomena must be fancied if they can not be found; for the idea of the earth's having been upheaved from the bottom of the ocean necessarily suggests the existence of some force having been sufficiently powerful for the subduction of gravity under the upheaving processes.

Now, what are we to infer from the favorite term "volcanic force," as applied to certain phenomena, and regarded as the root of this whole upheaving hypothesis? The term itself certainly conveys no very definite idea of its own powers or principles of action, nor do they who use it furnish us any very philosophical explanation as to how it could have become effective of the many phenomena attributed to it; neither do we find any intimation as to what could have generated its tremendous power during its periods of paroxysmal activity, or what at times soothed and softened its rigor, so that the convulsed earth should have intervals of repose. Something of course there must have been to influence the operations by which these powers could have effected the phenomena ascribed to them, so that in the scheme of nature they should not do or leave undone any thing but such as was proper. The igneous and upheaving hypothesis can only hold good in virtue of some law of its power for producing phenomena which can not be expected to extend indefinitely.

Of this order of force and rule of action, speculative geologists do not seem to have well informed themselves; they are altogther destitute of facts by which to fortify their theory, save in what they assume to be the analogical effects produced by volcanic action at the present period, mixed up with no small sprinkling of miraculous intervention; and this volcanic action they say is consequent from igneous action, and this igneous upheaving action is the result of a very high order of calorific action in the rocks of the earth; and the calorific action is caused by the chemical action, as induced by the sun or other substances, and the action of the sun and other substances is, in all likelihood, caused by some medium of an electric character that may be assumed to occupy all space and generates all activity. This order of circuitous and unsatisfactory reasoning is all we find in support of this assumed force to which so much is attributed; at least it is all we can make out of what geologists have to offer in support of the rule of force and action on which they found the igneous and upheaving hypothesis, and from which they assume the crystalline character of the granite and other so-called igneous rocks. These very forces themselves are far more incomprehensible than the phenomena they are thought to cause. Surely a force that could have been so effective in tossing about the solid matter of the earth, and sustaining it in its present position, would in its conduct be much more unaccountable than the simple circumstance of solid matter being primarily heaped up upon the earth somewhat irregularly, as in heaps of sand or mountains of any other more impalpable powder before the susceptiblity of crystallization had departed therefrom. However little may be known of the intrinsic character of the calorific principle itself, or of its order of action, it certainly should be known that much more has been imputed to its agency than it could possibly have accomplished.

Geological speculators, when entertaining themselves with the idea of internal combustions, convulsions, and alternating transpositions of earth and sea, would do well to satisfy the world and themselves on what philosophical grounds they suppose igneous fluidity would be less obedient to the laws of gravity than any other fluid substances of the same specific gravity. Every one is well aware that if the ocean were not acted on by extraneous force, it would remain in motionless placidity, and even adamantine solidity. One wise provision against this is the *expansion* and excitement caused by this very calorific action, which is certainly the cause of the ocean's fluidity; but it is no cause of the billow's tempestuosity or upheaving of that element.

This calorific action operating on the waters unequally, may be the means of inducing fluid motion among the constituent molecules themselves, but still in strict obedience to the laws of gravity and preservation of a uniform surface; while the undulating upheaving billows of the ocean are in total violation of this constant force, and this action of these waters in prolonged continuation is but an effort at restoration to its rule, which speedily reduces them again to a level. As the forces which cause the most tempestuous upheaving of the ocean have but a superficial application, their effect extends to only a very inconsiderable depth, and the most powerful or long-continued application of this agitating force has never been known to elevate the waters more than about twenty feet above their usual level. Now we can not perceive how igneous fluid could have had any internal power of upheaval *per se*, more than that of the aqueous fluid, particularly as it has a much greater specific gravity to be overcome in its disturbance. In our large smelting furnaces, where great masses of ponderable matter are reduced to igneous fusion, we find no greater indication of violence or disturbed action than in the same quantity of water or any other fluid substance before reaching the boiling point; and there will be no more irregularity of surface from any internally disturbing force of action than may be found in a pond of water not externally acted on, the fluids in either case when left to themselves being equally quiescent.

Now the specific gravity of the fluid rock would be at least three times that of water, and we find it elevated in the mountain peak more than a thousand times above the highest ocean wave; and not by prolonged surface-force like that which upheaves the ocean billows, but by an assumed focus of force situated somewhere far down in the depths of the earth, and having sufficient power to overcome all incumbent pressure that superior matter may impose by a depth of, it may be, hundreds of miles.

This seems rather a heavy tax on credulity so long as we are furnished with no evidence from which even to infer wherein igneous fluidity should have more power thus to elevate its matter so unevenly when we find no other fluid having any such power. All fluids (however much they may at times be made to rebel) are certainly, when not obstructed by extraneous forces, the most obedient subjects to the laws of gravity; and thus finding all fluids quiescent when not extraneously disturbed, why should we suppose it would have been otherwise had the whole earth been one fluid mass? and particularly while cooling down from incandescence, for in that event all must have equally participated in any reduction of temperature to which it could have been subject, so there would necessarily have been a general progressive and quiescent condensation of every species of matter constituting the mass; for in such a case none could have been subject to any degree of convulsive expansion whatever, much less such as could disturb the quiescence of the general whole in that manner of which geologists so much delight to speculate on.

On the whole we can not conceive a proposition more preposterous than that which makes "all the solid matter of the earth above a fluid level to have been upheaved by an internal igneous force," and that, too, at a time when the whole mass was in a state of internal fluidity. This is diametrically opposed to the greatest known power in nature, which could not have done otherwise than reduce all such fluid matter to a dead level, long before it could would be safe from the destructive effect of any substance that could condense and fall upon its surface.

Now this must have been the result had the mass of the earth ever been in a molten state, which is so generally assumed. The first-formed incrustation could never have been broken up by its own act or the effect of the constantly contracting matter that it inclosed, but would have constituted an eternal barrier beyond which not a particle of the inclosed matter could ever have escaped. Therefore the elevations could not have originated in this source, for such a process or condition of things as would have followed from igneous fusion must have totally and eternally subverted the whole order of nature, for the solid surface being thus such a perfect spheroid, the aqueous ocean would have been of uniform depth.

It will be equally impossible to perceive wherein any subsequent repetitions of the more partial application of the igneous action could have been any more effective of the upheaval of lands; for the high heat of the primeval mass must have totally expelled from, and prevented the formation and involvement of, any substances that could have been thereafter subject to expansion from any degree of temperature of less intensity than that from which they descended.

We certainly have here the most conclusive evidence that the great mass of the earth could never have been in a general state of calorific fluidity, and even if it had, that no upheavals could have been consequent therefrom. In all places we find granite to be the basis of stratified rock, in all instances it is irregular in level, and it is uniformly characterized by crystals; now supposing igneous fluidity to have been required previous to granitic crystallization and paroxysmal elevation, what order of economy can we imagine competent to have caused such local and partial increase of temperature as to fuse by a repetition in partiality all the granite of the earth, as though the whole had been operated on at the same time, and of which the upheavals are the expression of its restricted or partial power? Where, in the name of nature, are we to find the requisite forces for the rending of rocks and the lifting up of continents. The power assumed to have acted must have been situated at least below the strata, or ten miles below the surface of the matter to be uplifted, and how much more it may have been we are not informed; but even at this depth, and granting the uplifted matter to be only three times the specific gravity of water, it would have imposed a pressure upon the focus of power at least seventy-five thousand pounds to the square inch.

We know of no substance subject to sensible concentration in nature whose concentrations are so determined as to defy all other forces to prevent their resolution into gas. Every known power in nature must necessarily have its limit, and subetances subject to vaporization by heat when under compressive impact, can only expand by the subduction of such an amount of compressive power as is measurable by that limit, of which the mechanical force required for their reconversion to solidity may be more than equivalent, as we find in water and the aeriform substance into which it is convertible; for remove from the water but the common atmospheric pressure of fifteen pounds to the square inch and it is much more easily convertible into an aeriform state, but a much greater mechanical pressure is necessary to reconvert it back again into water. But be this as it may, physicists will fail in finding substances that could have been susceptible of gaseous expansions under the enormous pressure that must necessarily have been imposed upon the assumed seats of the upheaving power from which the respective portions of our earth are supposed to have been elevated.

Geologists, in their discussions respecting the conditions and the constituent matter of rocks (of which carbonaceous limestone may be considered an example), attribute the retention of concentrated gaseous components (at the time such rocks were operated on by heat, until their matter became crystalline) to the conservative effect of the incumbent pressure imposed upon them. Hence we should suppose that the philosophic thought which could measure the conservative effect of pressure upon the constituents of comparatively superficial strata, would know how to calculate its effect on substances of expansive susceptibilities when situated at a depth no less than we have contemplated. We can not conceive how pressure could have been a conservative of concentration in the one case, and have permitted the expansion in the other. If by the superimposed rocks and consequent pressure the carbonic acid could have been kept concentrated in the limestone beds while they were subject to such an assumed heat as could have caused their fusion and future crystallization, without resolving these carbonaceous constituents into gaseous expansion, when at no greater depth than where these crystalline limestones are occasionally found, we can not possibly conceive how heat could have caused any gaseous expansions of matter at a depth and under a pressure of at least from ten to any other given number of miles of solid matter, so as to have elevated it in the manner that such expansions are said to have done. The laws of nature are not thus warped about at will; what is effective in one case must be so in others, circumstances and conditions being the same. Thus we find the question of "Where are the upheaving forces?" narrowing itself down till it is only answered by its own echo—"Where?"

Chapter Ten.

Gaseous Expansion—Water—Stratification—Solidification of Gases—Pressure—Discrepancies—Formation of Atmosphere.

WERE gaseous expansions even admissible as a measure of indefinite power, this would by no means solve the problem; for by what conceivable application of this power to the molten matter of granite could we expect it to effect the inequalities we find in the surface of that substance? and even had it caused undulations, or mountainous elevation, how could it have sustained them against the continuous action of the equivalent of the upheaving force until they were solidified? If, therefore, the assumed geological upheavals by the expansibility of gaseous substances under high heat remain no longer a problem to be solved, but a proposition to be regarded as totally exploded, we find igneous agency is thereby divested of the most important characteristics claimed for it as a power-generating principle. For if the force effective of upheavals by the igneous enlargement of substances is all that is to be calculated on, they can only be estimated in the simple ratio of their expansion by heat without transformation into gas. It will not be difficult to perceive how completely inadequate this must be to effect any of the lofty upheavals of matter characterizing the earth's surface, for the expansion consequent from simple fusion is of by far too limited a character to be counted on as a cause of the elevation of the earth from the bottom of the ocean to its present position; and had it cooled down within its crust, as is supposed, by refrigeration, it could not have swelled beyond it by subsequent fusion. Thus, we think, we have demonstrated that the geological facts themselves (which are the foundation for the idea of those hypothetical forces) remain to be accounted for by some very different cause than these fancy forces of volcanic character on which geologists count with such seeming confidence.

We will now return from the further contemplation of this speculative effort of philosophy to find by induction the dynamical forces for the furtherance of an assumed system of development that never could have existed in nature, and resume our inquiries by the more legitimate rule of rigorously deducing from the first principles of physical nature its necessary results; which process of inquiry, we conceive, has so far served us well in the demonstration of what must have been their sensible effects in phenomenal development.

Agreeable to this rule, geological facts, of whatever denomination, are only to be considered as regular sequences in the great series of progression by which the grand scheme of the physical creation is pushed forward to finality. We have already followed this order of progression and aggregation from its source to its formation, position, and effective action of all that vast accumulation of matter now comprehending the whole granite base as its exterior, and on which rests the entire superstructure of stratified rocks, but find in it no reason why, from necessity or otherwise, it should have been in a state of igneous fusion; therefore the crystallization of the granite, or other peculiarities of its structural formation, could not have been confined to any special period in the changing vicissitudes of heat and cold, while the earth was refrigerating down from incandescence. Chemical or molecular affinity, and the condition of that matter from its aggregation until now, must have caused the modification leading to its present crystalline character without the instrumentality of any high heat. This very granitic matter would, in the ordinary process of nature, undergo very considerable modification of character from its primitive state before the epoch arrived when it became part of the earth's mass; for we perceive that affinitive action had considerably progressed before the granitic matter could have been so often constrained to take its place so far above what the earth's common center of gravity would have otherwise determined. Now may it not be unmistakably perceived wherein the molecules of this matter must have been in the most fitting condition to have affinitively effected the formation of granitic crystals; for its present structural or crystalline character could have been determined only by conditions most favorable to this effect. It requires to be considered that the different phases in nature's multifarious phenomena, as following each other in progressive succession, must have required an almost measureless extent of time for their several accomplishments. The structure of the granitic rocks, therefore, was not restricted to any contingency of time, hastened by excess of heat, and contrary to the common rule of physical progression of affinitive action; and we have not yet found under what circumstances of affinitive action all this granitic matter could have been fused for the formation of its crystals while its matter had not yet been solidified so as to have required its fusion.

As nature presents no useless conditions in the way of her economy, we perceive the absurdity of inferring igneous action to further the production of a condition from which there never had been yet any departure. The very facts presented in the granitic structure itself furnish the best possible evidence that the molecules of all this matter were in the most fitting condition, by their own affinities, to effect the very crystalline character of these rocks. And while such was the case with their constituent matter, the structural formation must at such period have been very much facilitated by its intermixture with aqueous ingredients which at this epoch, as we shall presently show, must have begun to exhibit themselves in very considerable quantities, sufficient at least to have saturated the more ponderable matter of granite, for the crystalline structure and solidification of which it was highly essential.

The existence of water at this particular epoch may not be so evidently traceable in the granite formation itself, neither could it at this time have affected matter to any great degree except in the facilitating molecular association and assimilation among themselves; for there are no indications of its operation as a moving power, and we are only able to recognize its action in a more palpable form in this respect where we first find stratified matter outspread over the surface of the more homogeneous and regularly crystallized granite.

Although the agency of water is unquestionably of the utmost importance in almost every operation of nature, and its effects conspicuous so far as we can usually explore the rocks of the earth, still its indications become less and less appreciable, until they altogether disappear in the granite, except so far as its crystallization may have been thereby facilitated. Now this is what we should expect of this species of matter, when we reflect that it is decomposible into two sensible substances of a highly expansive and gaseous character; and even when combined, and in their most concentrated state, their affinitive forces are so feeble as to be only one fourth the ponderosity of some of the rocks. General circumstances must have been highly favorable before these two distinct forms of matter would have combined and concentrated thus. Here we find the formation of water as but one more sequence in the order of physical progression, its period of formation being *à posteriori* of the causes which could have induced its development, not the least of which must have been the force of accumulated and accumulating pressure, together with time for the sensible constituents of water to separate themselves from their association with insensible matter in their gaseous condition, and to combine in the more concentrated aqueous form. These gaseous constituents of water must have enveloped the nucleus portion of the earth as an atmosphere, and could not have been combined in aqueous relations until the aggregation of the earth's mass had progressed to nearly her present bulk, and at the time she was completing the accumulation of her granitic matter; for although the granite seems to bear no sensible indications of aqueous action, as though an ocean had covered the earth at that period, still water was probably in process of formation in such quantities as would have mingled with other falling matter of greater solidity.

The stratified rocks that rest immediately upon the granite, and that often pass so imperceptibly into the unstratified, furnish the first and best evidence that water had begun to accumulate, and in quantities more than sufficient for the saturation of the more solid matter that had descended, or was at the same time falling, and which was augmenting itself into an ocean through which all subsequently descending matter would have to pass. It will be important to observe here, that the present profile of the granite proper may not be that which obtained at the time the water first began to overspread the earth, as our future observations will confirm. Our object now is to point out the circumstances and epoch at which water began its formation and was in the full exercise of its modifying functions. It will be perceived that this substance can be considered as only of a secondary character, and altogether depending upon circumstances in the grand series of progressive development; therefore we must observe the circumstances which brought this formation about as a sequence in the great and progressive order of all things, and the most legitimate inference from observable facts is, that at this particular period all conditions were favorable for the appearance of water consequent from the condensation and association of its sensible constituents, which could only take place when the pressure was accumulated sufficient to force or facilitate the combination of these two effective gases in the formation of the aqueous substance. And this required pressure could not have prevailed until the earth had accumulated a great portion of her present bulk, or at least that of her compressive envelope.

We may further infer this from the readiness with which even combined constituents of water in their molecular forms resolve themselves into vapor even under all the pressure the earth's enveloping mass imposes. If these propositions and observations were not in themselves self-evident, they would have full corroboration from the moon's testimony; and if she is sometimes accused of misleading the mind, we need not fear misdirection in this instance. We must admit that her sensible mass is of no inconsiderable magnitude, yet the comparative power of her insensible envelope is altogether insufficient to manufacture water for her many vast depressions or basins now known to be empty; the closest observation shows no indication of water on her whole surface; nor can the aqueous constituents combine under such feeble compressive power as the moon's magnitude shows the pressure of her envelope to be. So the affinities that form water, as we thus see, would require to be under the influence of much greater pressure than we may asssume the moon's gravitating envelope could impose, before they could be aqueously effective at all.

But as respects our earth, the progressive accession of substances to her surface would not only enlarge the circumference of her sensible nucleus, but in still greater and constantly increasing ratio enlarge her compressive envelope, because her accumulation of cosmical substances must have succeeded each other in the order of progression, and at vast periods of intervening time, owing to the different depths of space through which they had to pass in their descent. It may therefore be calculated that the relative quantities of insensible matter to the solid nucleus portions would be in the ratio of such time, by their being longer in those regions where they could gather up the more etherealized matter; for time is in such cases but the relative measure of the spaces through which they must have descended. They, as is evident from their progression in space and succession in time, must have become more and more of the etherealized character of cometic bodies; and many of them may have even descended in convoluted curvature of orbit many times round the earth before reaching her surface and blending their insensible atmospheres with hers, and their solid matter with her sensible surface. In thus legitimately following up the progressive order of cosmical events, we perceive that as the earth's aggregating process approximated its termination, substances descending from more and more remote realms of space would be of lighter and less affected matter, and the gaseous constituents of water would unquestionably constitute no inconsiderable portion of most of them; and these would be almost wholly disposed of in the earth's exterior envelope; for only the nucleus portions would be of ponderosity sufficient to incorporate with her sensible matter, and we thence infer that when these last contributions were affinitively disposed of under the accumulating pressure, the formation of water must have ensued; for when we contemplate that extensive addition made to her sensible mass, which embraces all the matter constituting her stratified deposits, and since water had begun to form, we are left without other alternative than to suppose it made up of the nucleus matter of those substances which have from time to time been entangled in the atmosphere and impinged upon the more sensible surface. We see in these progressive and extensive accumulations how pressure became sufficient for and favorable to the affinitive formation of water, and likewise from whence the constituents of water were furnished, and how these constituents in their gaseous state would serve to augment the very pressure by which they themselves would be reduced, so as to combine in the concentrated state of water.

Thus are we able to trace the formative effect of the earth's increasing envelope in the origination of water, from the first mists that fell to the mighty oceans that now flow. This process of the formation of water, occupying an immensity of time, must have had many and prolonged intermissions, and every reception of a substance from external space would impart both aqueous components, and the pressure that would compel their transformation into an aqueous substance.

Therefore water must have descended in rain more or less copious and continuous in the ratio of the augmentations received from these contributing bodies; this, too, would follow the general rule of all forming fluid substances, and concentrate in spherical globules, as we find it now doing in the mists and rains that so often surround us. No doubt but much of the first falling water would intermix to saturation with the earth's more solid matter before it would begin to fill the basin-shaped depressions caused by the irregular distributions of falling substances over her surface.

The transformation of the aqueous constituents into water, and the deposition of the sedimentary matter composing the stratified rocks, must have taken place more and more simultaneously, as the pressure accumulated in sufficient degrees, for all the matter composing these rocks and in the formation of water must have had their origin in spherical substances of more or less magnitudes, descending from external space. These spherical bodies of cometic character when descended and in coalescence would contribute their extensive atmospheres to the earth's envelope, while their inconsiderable nucleuses of more energetic character would be precipitated on her solid surface, so that for every fresh contribution made to the solid matter there would be an extensive transformation of the component matter of her envelope into water, corresponding with the magnitude of the contribution and its aqueously disposed molecules.

Then it would be in reality that "the windows of heaven would open" and deluge the earth with floods of freshly formed waters. Chemists and experimentalists impose artificial pressure so as to cause liquefication and even solidification of gases; and they admit that if water was relieved from atmospheric pressure it would resolve itself into invisible vapor much more readily than now. Consequently had there been no atmospheric pressure, and none of the outer pressure beyond the sensible atmosphere, there could never have been such a substance as water at all, for under such circumstances its own component affinities could not have formed it into any such a substance; and it is even questionable if the aqueous components would have been so far denuded of their atmospheres as to have combined in the formation of any sensible thing whatever. Seeing, therefore, that all gaseous substances are reducible to solidity only when they are under the influence of pressure, and as a further proof of which it is found that many liquid and solid substances resolve themselves into gaseous invisibility on the removal of more or less pressure, may it not be that the maximum amount of atmospheric pressure, both visible and invisible, is as equally requisite for the formation of every sensible substance belonging to the earth? We do philosophically infer and boldly assert that were all pressure totally removed from our solid earth, there would not remain one particle of her whole mass appreciable by any of our senses, because molecular affinity is in itself altogether inefficient for the formation of a sensible condition of matter in any form, unless under what we may call an infinity of fluid pressure; relieved from this, the formative affinities of all sensible matter would instantly resolve its molecules into a gaseous expansion by the affectionate enlargement of their own sphericities. To this pressure all substances are equally subject at equal distances from the common center of gravity; their own forces, acting under this uniformly prevalent power, thereby become their formative forces, nor could these native affinities of their own molecules have made them what they are only under this prevalent influence of the pressure of the whole to a point.

It will be perceived that the molecular effectivities of matter are equally the formative forces of the constituent sphericles of all sensible substances, as that their general center seeking combinations of power constructs that force of pressure under which alone it is that molecular forces can make substances of any sort solid, or even sensible at all.

We have observed that the aqueous substance, when relieved from the pressure of the common atmosphere much more readily resolves itself into expanded vapor by its molecular enlargements, even when its constituents continue in combination, than it does when subject to such pressure. This is certainly an evidence that pressure is essential to the reduction of matter (even in its most effective molecules) into visibility.

If these components in their combined form are so readily resolvable into gaseous expansibility when relieved from pressure, pressure must be a prerequisite of their liquid condition, and certainly at least equally so in the reduction of these constituent gases to a com bination with each other at all. Hence we perceive that water could not have been formed without such compressive reduction of its constituents as could cause their combination, because their own inherent affinities had already satisfied themselves in the formation of their gaseous sphericities. Neither could this combination of these aqueous constituents have formed water but under a greater degree of compression than that which was required for their union, because the compound force had already satisfied itself in their formation into gaseous vapor. From this system of safe reasoning we arrive at the very important fact, that the waters of the earth could not have been formed until the earth's compressive envelope had been aggregated to that extent which would cause the requisite pressure, under which the effectivities of the aqueous constituents could construct them into water. From all this, the epoch in the earth's progressive development, when the waters were formed and fell upon her face, is a subject, as we see, highly susceptible of deduction; so that we have not only the proof of its introduction and epoch of its deposit in this way, but there are likewise evidences of it treasured up in our earth's stratified rocks, for it has left the impress of its earliest action on these rocks, which could not have assumed this form but under its effect.

The discrepancies between what we thus regard as the truths of nature and the inferences of philosophers will be found to prevail greatly as we proceed with the investigation of geological development, and among the first and most important we find the idea to prevail, that strata were outspread in a plane approximating to that of the horizon. Now should this assumption, so fundamental in its character, be erroneous, it would be very unfortunate for the speculations of those entertaining it, for it involves the consideration of the causes which they assign as leading to its altered condition, and about which they have so much occupied themselves, and to such little purpose should it turn out that they have never been upheaved at all.

For every phenomenal fact found narrated in nature's great volume there must have been a relative rule rationally determining to and accounting for each respective expression; and had the stratified deposits been first in a plane, what rule or rational argument do we find for such revolution as would place them in their present conditions? This problem has not yet been solved satisfactorily; the causes hitherto assigned involve so many inconsistencies, contradictions, and overstrained inferences, as to render them totally inconclusive of the facts for which they are assumed to be answerable. We are under the conviction that geologists have fallen into a most unfortunate error (one that must be fatal to any just interpretation of the records of primeval times, as treasured up in and transmissible by the monumental archives open for geological exploration) when they adopt the idea that the whole series of variously alternating beds of stratified rocks, superior to the granitic base, were deposited in a plane, very nearly approximating to that of the horizon, and the whole matter for these formations furnished by the degradation of that very granitic base, either directly or by the detrital matter of other rocks previously existing, and which had their primary supplies from the same primary source. And that for this aqueous agency was the effective principle for the abrasion, suspension, transposition, and deposition of all this detrital matter in the multifarious kinds, qualities, and characteristics distinguishing the different beds. If these assumed propositions, so continually before the minds of geological investigators as elements of inquiry, carry with them any conviction, it must be, to a truly philosophic mind, that of their own absurdity.

There are, in the first place, no known forces in nature by which such a primary position of the earth's stratified rocks could have been revolutionized into their present conditions. Neither could degradation have furnished matter enough for the ten miles' depth of stratified rocks, which geologists usually assume to be the average depth of the earth's crust. The very assumption of the horizontal expansion of strata would imply the same position for the face of the foundation rock on which those materials were deposited. How, therefore, could this level plane have been exposed to the erosive action of the waters? Or what part of the primitive ocean could have been so partially destructive to its own bottom as to have dug up the matter on which these very stratified rocks rested, and transported it so as to form stratified beds ten or more miles deep?

We see no reason to suppose the primitive seas were more destructive in their effects than the oceans of the present day, or that they should have been more partially so, particularly as they were of a uniform depth, the sea bottom being thus level, which would contribute to uniformity of temperature, and but little disturbed action. Most assuredly the first settlings of sedimentary matter upon the level bottom of these primitive seas must have protected them from all further erosive action, even if there had been such activity in the waters as to have been erosive at all. Deposit is so much the reverse of erosion as to forbid the idea that both could take place simultaneously on the same plane.

If stratified matter had its derivation in previously existing rocks, from what part of the primitive world could the requisite material for all this mass of rocks have been furnished? Their matter could not have been excavated from under themselves; then how deep must be the pit, and where situated, from which all this vast quantity could have been dug? This question so necessarily propounding itself as a product of the premises, may possibly puzzle geologists themselves. We are certain that no one uninitiated into the mysteries of that science will be able to imagine how so much matter could continuously make its way to the top as ultimately to form the whole series of stratified rocks. When we take into consideration the protective rocks of primary stratification, almost invariably found incumbent on the granite, these certainly give us the best assurance that this foundation rock was early covered up and safe from casualty of flood or force which could remove its matter. The relative portions of the granitic surface now exposed by denudation (had they been elevated as high as the moon), could have furnished but a small portion of the matter required for the earth's strata. From this and many other things that may be adduced, we see that the propositions of geologists with respect to the origin of the stratified materials of the earth, and its assumed order of deposits, has more to contend against than can by any means be overcome, and of which we have sufficiently shown the absurdity. For were they right in their proposition, nature could have had but little other object in view than the ostentatious exhibition of her revolutionary powers, rectifying what she may as well have done right at first; and we do not find her indulging in any capriciousness of conduct, but bringing her purposes forward to their full development by the most direct processes of easy progression, and with the least prodigality of expenditure in means.

But leaving such physical speculators to their own mental misconceptions and bewilderments, we will again have recourse to nature's legitimate process of progression, and ascertain by what more effective method she gave expression to the geological facts found recorded in the rocks of ages, of whose origin so little is understood in the right sense. We have already considered the concentrating substances of meteoric character, of which the earth is one of the final aggregates; they must each have had a time of isolated individuality more or less prolonged, while poised in or traversing the vast regions of space between them and the bodies of which they now form a part, and proportional to the respective times of their ultimate attachment. When occupying these isolated positions in space, it is to be expected that their constituent matter would make some effective progress in molecular formation; for, as isolated aggregates, there can be no question but their affinitive molecules would have such attraction for each other as to push forward their own progression parallel with the affinities by which they were respectively affected, and the circumstantive conditions attending them; the consequence of this would be, that the most effective matter of these substances would, in process of time, become more and more incapacitated for operating in its fluid relations, so as to become confluent with the matter of the earth on coalescing with that body.

We have found that the earth could have continued of a true spherical form with perfect uniformity of surface only while the matter it had made its own, and the matter of external substances, remained sufficiently fluid to flow down in perfect equalization of surface, in obedience to the common gravitating attraction. This spheroidal form of the earth is certainly the very best evidence of the fact that such must have been the condition of her matter when she first began her periodical passages round the sun; otherwise she would have been ill qualified for taking a form coinciding so exactly with her diurnal revolutions.

But while this must have been her condition at the time of her entering into the solar association, circumstances must have greatly changed the character of her subsequent accumulations, particularly about the granitic epoch; for we find that characterized by great irregularity of surface, as we might expect at the dawning formation of water; for in its absence accumulations of solid particles, however finely characterized, could not have flowed down into perfectly level sphericity.

We do not suppose the condition of the atmosphere to have been the same then as it now is, or so dense as effectually to have dissipated or dispersed all the matter of substances descending from space to the surface of the earth's solid nucleus as to have spread them out evenly. And there being as yet no aqueous oceans into which this matter could have been precipitated, interspersed, and deposited, the necessary inference is, that there would be but little resistance to the gravitating force by which such bodies fell, so their matter would have impinged upon the earth in little less than the full force of its gravitating descent, and thereto have connected in massive inequalities, more or less protuberant, and with no reference to regularity in the direction of descent, as there would be no order in their positions of impingement.

As we have full proof that the formation of water could have made but little progress at this particular epoch of the accession of the granitic ingredients, we may infer something of an analogous nature in the construction of the atmosphere; that, too, being a compound substance, certain circumstances would be essential for the combination of its constituents. Their volatility must have been subdued by pressure before they could possibly have united in the construction of our common atmosphere. The particular era of atmospheric introduction is not so well indicated as that of water, still we infer that it could not well have preceded it, and we are sure it must have been introduced in its present form at an advanced stage of the aggregating process, because if pressure was essential for the combination of the constituents of water, it must have been equally, if not more so, for the combination of atmospheric constituents; but whether previous or subsequent to the formation of water, may be a little uncertain, and is not here material; but we do positively infer that its powers of resistance in primeval times must have been much more feeble than they now are, or the granitic matter, after passing through it, could not have been piled up in mountainous heights in the manner it now is.

Thus we find every physical expression in creative development telling the tale of every other subsequent sequence in the eternal unity of all things, and as alone consequent from the effectivity of first principles or attributes of Jehovah, imparting visible expression to his invisible will, without the immediate act or special volition of this principle of will. His attributes and agencies being the realization of *eternity*, and they alone having effectuated physical character in all its phases, *time*, as a term, is totally inapplicable; for there can be neither mark nor measure on this endless idea that can indicate the calculable epoch when these elementary principles were first excited by Omnipotent Will to physical effectivity; neither is there from that epoch of physics' first inception to the fulfillment of the granitic era, or any other phase in physical formation, any index or scale of division by which to calculate the length of the mighty cycles in creative progression; yet however prolonged may have been the period between one creative development and another, they having passed in this lengthened progression, is the most conclusive of there having been a period in the eternal continuity when this physical progress began. It has been truly said, that there is, or has been, a time for all created things, and we can as truly say that there has been an eternity for the uncreated elements of all created things. And who will be found so wise as to designate how far back on this roll of never-ending retrospect it was that these everlasting elements were first called into practical activity, so as to give sensible expression to creative thought in the construction of a physical universe, or even to tell the intervals of subdivision in time's eternal calendar at which the several expressions were given to this physical scheme of the great creative I Am, with whom a thousand years are as one day, and one day as a thousand years. Finite mind, of however much it may be capable, must fall far short in such computations as these problems present. Man was until recently perfectly satisfied with created things having had a duration of about six thousand years; and so he may have continued, had not geologists found the archives in which nature has made truthful record of her own progressive operations; and although geologists may have much misinterpreted her chroniclings, they are not in error when they conceive the times between the several recorded events to be immeasurable. They can truthfully trace them in their progression, and tell which preceded which in the relative order of such progression; but they can not tell the duration of this progression, nor how long it took for the development of either of its phenomenal phases. In all there is evidence of vast but undefinable extension, which would perhaps be incomprehensible, were they even reduced to the mathematical terms of a series. If, therefore, there are in this ten miles of our earth's depth records of antiquity that tell of the immeasurable time occupied in its formation, what can be conjectured with respect to the whole depth, of which this recorded portion comprehends only about a four hundredth part? Thus perceiving that the length of time taken in the formation of our earth's stratified rocks is incomprehensible, how can we conceive of its lapse from the first germination of things to the final of the granitic formation which constitutes the base of this superior order of rocks? But whatever may have been the age of the world when these stratified deposits began, we may be sure that the energies of matter must by this time have so changed it from its primary condition as to have precluded the possibility of its accumulations resolving themselves into a level surface. Of this the granitic profile is conclusive evidence; for as gravity had fashioned and laid down its constituent matter agreeable to its affinitive condition, so it must have remained, except when exposed to erosive action; for the force which could effect this precipitation from the utmost bounds of solar space, would be unlikely to allow any infraction of its powers when thus exercising them in their maximum intensity.

Chapter Eleven.

Physical Unity—Position of Rock—Primitive Strata—Igneous Action—Argillaceous Matter—Metals—Limestone—Chemical Changes—Assimilation of Matter—Fractures in Rock—Transition Period—Formation of the Waters—Transmutation.

ALL may readily perceive the absurdity of expecting to find physical unity effected by a system of forces that are so absolutely antagonistical to each other as those that are assumed to be the ultimate effectivities of nature; and as the attractive force by which energetic matter concentrates itself could not by any possibility generate that which was not only perfectly opposed to its own energy, but even so superior as to dissipate the very matter that it otherwise would have attracted together, and that, too, when the law of this concentrating force had ruled it to its maximum rate; seeing, therefore, that the attractive force could not possibly originate a power repellant of the effect of its own energy, they who will persist in this system of positive contradictions have no other alternative but to attribute them to nature's Omnipotent Originator, while a moment's reflection will make manifest the fact that contradictions can constitute no part of the character of this All-creative Will.

It certainly must be a very unsound system of philosophy that has to assume contradictions in the creative elements in order to account for the observed facts, and is only calculated to inculcate perverted conceptions both of physical nature and the power of whose will physical nature is but the expression.

To the attractive and repulsive antagonisms thus assumed by physicists we find them attaching equal importance, although unable to define the rule by which they become so complacently effective of the infinity of ever-changing phenomena. These forces being so diametrically antagonistical to each other, is sufficient evidence of their joint inadmissibility as elementary forces effective of physics, so that one being admitted as a fact, must altogether preclude the other from being so considered.

This is an alternative from which physicists have no escape, and which demonstrates the most conclusively their systems to be unsound, because they are either compelled to maintain an absurdity or suffer their systems to fall, for the truths of nature can have no two ways, and if attraction be a physical truth, that which is in direct opposition must be a falsehood, and such physical contradictions could not be made to operate in unison.

While we are thus demonstrating by unmistakable means the fate of the existing physical systems that are founded on a plurality of adverse forces, we are at the same time demonstrating the further important fact that the rocks of the earth which are subject to geological inspection, in place of having undergone the revolutions contemplated in speculative geology as consequent from the internal expansions of substances caused by repulsive forces, and thereby producing the upheavals of both the stratified rocks and the foundation on which they rest, they could have been subject to no such convulsive upturnings, but are still in their primitive positions; for without an adequate power as opposed to the ponderosity of the upheaved mountains, islands, and continents, there could have occured no such upheavings of the earth; and we have fully demonstrated that such a power there could not have been, any upheaving power being necessarily within definite limits, and very far short of effecting the upturnings that are so usually assumed.

It will be observed that the granitic foundation on which the stratified formations rest, is highly characterized by elevations and depressions of surface-level; we have seen that from a fluid condition of this rock it could not have been so consolidated, and we have demonstrated conditions to have been such as that this matter must have been so deposited; it is not therefore to be inferred but that matter deposited thereon would be conformable to these inclinations of the surface on which it was made to rest. The granitic and stratified formations are so often found graduating into each either as to be a proof of this fact: at least this is sufficient to show that at these junctions one must have been subject to the same vicissitudes as the other, and had it even been that the granite, while in a state of igneous fluidity, had been upraised so as to have upheaved the stratified beds, as is assumed, would this igneous fluid not have again subsided to a level long before its consolidation could have taken place? and if so, how is it that we now find it conforming to all the angles and flexures of these same uptossed beds? This whole scheme of horizontality, and subsequent upheaval of the stratified rocks of the earth to their present positions, has to be sustained by such far-fetched argument as can have but little force against the many positive contradictions that almost everywhere present themselves.

In such primitive times as when the earth was receiving the matter for her first-formed strata, and before the incumbent atmosphere, sensible or insensible, could have attained to any thing like its present condition and pressure, and in all probability before our present sensible atmosphere was constituted at all, the new-formed ocean must have been in little less than profound tranquillity, the circumstances of such times giving cause to but little disturbance, except on occasions of the earth's reception of aqueous or other matter, as consequent from coalescing substances. These accessions of solid matter would be received and disseminated in the ocean, and from which gradually precipitated upon the bottom, where it would be left to rest precisely as it fell; and in conformation with the surface on which it was deposited, such tranquil seas could not have washed it down into the depressions, except when the prominences on which it was deposited projected themselves to the surface or positions of exposure.

In passing from the granite proper into the primary strata, the transition passage is almost imperceptible among a class of rocks all more or less of crystalline character, and variously named and characterized, but with no very definite order of superposition, being found transposing and passing into each other and into the granite in every grade of character and relative grouping.

This order of primary strata has puzzled geological inquirers not a little to account for this crystallization of these rocks that they assume to have had a mechanical origin. They have conceived the most incomprehensible circumstances to have taken place with respect to their assumed metamorphosis of character, as they say, from aqueous deposits of detrital matter procured in some way, and transported from somewhere to granitic or semi-granitic rock of crystalline structure, and with stratification conformable to the contortions of their base, because of these rocks having all been subject to fusion or semifusion together. They have imagined igneous fusions and semifusions to no small extent, and while in these conditions they have conjectured the injection of interstratified beds of this matter among other less liquefied rocks raised for its especial intrusion over extensive areas, seeming now as if they had been associately deposited among the same aqueously stratified beds. They furthermore speculate on fused injections of different kinds of matter, among rocks, in beds, dikes, seams, or veins of every variety of character and aspect, ramifying the regularly stratified beds between and at every possible inclination to their planes of deposit, and intersecting, abutting up against, or cutting each other in their continuations, affording what is supposed to be proof of their relative ages or times of intrusion. From observations on some certain sections, they have satisfied themselves that they have found evidence of as many as eight or ten intrusions of matter which have penetrated these rocks at different periods, and of as many different fused kinds of this intruding matter.

Now when we contemplate the countless seams of these insinuated rocks of supposed igneous origin in all their parallel interpositions among the stratified beds, and traversing them and each other at an infinity of angles and tortuous sinuosities, as well as in every grade of persistency and thickness from a line to beds and partition walls of many yards, we may well be amused or amazed at the matchless credulity of these fusive injectionists who entertain with so much faith the idea of such an absurd system of causes for these particularly interposed formations. Of all the complexity of this suppositionally intrusive matter, particularly in and among the rocks regarded as primary strata, and even the foundation on which they repose, geologists seem to have the ready faculty of supposing all the requisite ruptures and rendings now occupied with this matter to be the result of the igneous fusion and upbursts that filled them.

This idea of igneous action being by them once admitted as an effective agent at any one epoch, they see no reason why it may not have been repeated again and again. Indeed, this igneous notion seems to be ever present with them, so much so, that we are almost surprised to find any fact connected with primary strata for which it is not held responsible. Yet, we would ask, what became of the fused matter (always so ready to run into every opening), even of less than a single line in width, when the rocks were rent and walls of clay, and sometimes sandstone, inserted in the fractures and dislocations, and at times substances characterized as the granite itself, and likewise that of the primary strata? these, of course, can not, at least all of them, be counted on as primary or igneous injections, though quite as complete in their occupation of the assumed openings.

Now as the fracturing and fusing philosophy is altogether insufficient to account for the cause of these argillaceous intrusions, we remain uninformed about the force that could have effected the rending of the rocks and intrusion of this matter, or from whence the injected matter could have been derived, or how infiltrated into the fissures it fills, whether from above, below, or longitudinally. It is evident that if the disrupting of rocks and filling the fissures with crystalline matter were caused by the igneous irruption of this matter, the rending of rocks and filling the fissures with clay or sandstone could not have been from the same cause.

When philosophers notice this exception to their general rule, they signify that this argillaceous filling of fissures was effected by the infiltration, but respecting the rule of the exception they do not enlighten us. The simple statement seems to depend upon itself for support. If the fissures were formed before the infiltration, we do not see how they could escape being filled with igneous matter at the epochs of eruption, for if this matter was so intrusively insinuating that the rocks through which it ran could not cool and stop its progress, however thin the seam, it is difficult to conjecture how the clay veins could have escaped its insinuation, and particularly if the ruptures were effected by igneous upbursts. And if not thus effected, what occasioned the chasms now filled with clay, and other different kinds of matter? They must certainly be referable to some general ruler, and so must the matter filling them, whether regarded as igneous injection or aqueous infiltration. Either case equally involves the conclusion, that the intruded matter must have been transported, or pushed forward from some primary source to its present position; but the question is, Where was the primary source? for on this subject we are not well enlightened. Judging from the character of the intruded rocks, there must have been several sources from which even some single sections were filled, while approximate fissures seem to have been differently dealt with. How are we to designate the respective depths of the earth furnishing the matter severally designated as granitic, syenitic, porphyritic, trachytic, serpentine, greenstone, etc.? Is it conceivable that the same igneous circumstances and source could have produced these differently characterized rocks, and their perpetual passages into each other by such insensible gradations as makes the variety almost endless? How comes it that the same continuous masses were changed into every possible grade? Neither fire nor flood explains how this passage could have taken place.

Had there been sufficient calorific action somewhere, as is supposed deep down in the bowels of the earth, to fuse the rocks there into molten lava, how could that have filled the fissures or formed the beds at the surface? And even supposing there had been force sufficient for its ejectment, how could it have been metamorphosed into all the conditions characterizing these rocks, in their perpetually assimilating passages? Surely if a subterranean source sent forth molten matter to fill fissures, this matter must be of the same material as the fused rocks from whence it came, for this very fusion would make it all of equal character.

Some of these veins seem, even to geologists themselves, so unlike igneous injections, that they have suggested the possibility of segregation, which is as much as saying that when the matter of the vein-penetrated rocks was cooling down from its primitive heat to solidity, that the matter of the segregated veins is supposed to have been separated from the general mass of the rock by its own electric affinity, and thus found a place in the opening fissures. Now this is a more sensible idea than any other they advance, though we may find even this to be far from the fact.

Besides all these crystalline veins and clay dykes intersecting primitive and other rocks, there are likewise the metalliferous veins, with all their diversified characteristics; what is to be said of them? they seem to be no better accounted for than the others. This matter at least could not have been the detrital matter of abraded rocks. They do not seem attributable to either igneous infusion, aqueous infiltration, or segregation of matter when refrigerating from fusion. How is it that different veins in the same rock, or series of rocks, are charged with different metallic substances? By what process were the different metals and their matrix intruded into the fissures of the rocks at all, and what principle of preference decided their selection? We should have supposed all the rents would have been alike ready for the reception of the metals. But they do not tell us why veins were made the metallic repositories, nor why special selections should have been made for particular kinds. If it was because open fissures formed capacious and roomy apartments for their residence, by what intuitive perception were their particles directed thither? and from whence did they make their migratory march?

All these subjects have been more or less speculated on, but, so far as we can see, to but little purpose; at least there has been no proposition of any general principle to which they can all be attributed; for what explains one obscures others, and indeed seldom serves for the explanation of any single fact under all its circumstances. Therefore the manner in which nature produced all these phenomenal facts must still be a mystery; for it is determinable on the principle of her unity, that she could have had but one order of procedure; and the principles that could have been efficacious in the production of her facts must be equally so for their explanation; and whenever they become comprehensible, we shall see they do not conflict, for the forces of nature are the truths of nature sensibly manifesting themselves in her phenomena.

As we have already observed, the phenomenal expressions of physical nature are but a reply to the effectivity of her first principles, and must necessarily have succeeded each other in the series of creative progression, as consequent terms in the same total of unity. Hence there is but little hope for philosophy while her cultivators seek in a circle of contrarieties for true causes. They certainly have not succeeded in their efforts to make either fire, water, or electric affinity accountable in a general sense for the many general facts connected with the first-formed series of strata, and the other primary rocks associated with them, particularly crystalline limestone. Had igneous action caused this condition by a metamorphosis of the limestone bed, carbon could not by any means be one of its components, for the high temperature and force that could have fused or injected the limestone beds would have resolved and entirely dissipated this compound, notwithstanding what geologists say about pressure being a preventive of its escape, for pressure could not have been at all times present in the preventive quantity.

When they find crystalline or semi-crystalline rocks of other character without evident traces of stratification (whatever be their relative positions with respect to other rocks), they have no hesitation in attributing them to the intrusion of fluid matter caused by the same igneous action which they say metamorphosed the primary strata among which they are mixed. Now these limestone rocks being usually of a still more crystalline character than many others supposed to be of undoubted igneous origin, and at the same time assumed to have been injected, certainly indicate the same origin and intrusion, and geologists fail to inform us of any other possible process by which they could have been interposed between the stratified beds. And if it is impossible that these limestone beds could be injected while in a molten state, we do not see how the others could claim such an origin.

We are at a loss to perceive why one class of crystalline rocks should be denied the origin granted so freely and fully to others of a similar character. If igneous fusion and injections effected the position and structural condition of crystalline and stratified rocks as a general rule, why should there be exceptions when both are equally crystalline and intermediate of stratified beds?

Geologists themselves seem to disagree as to the origin of the limestone rocks of crystalline character, some maintaining that they are of igneous, and others of aqueous origin, so altered by subsequent heat as to obliterate all traces of their stratification and aqueous origin.

These differences of opinion among the geologists themselves make the matter so uncertain as to indicate a possibility of there being intermediate beds of unstratified crystalline rocks without any forcible intrusion of their matter in a molten state, or of having been subsequently metamorphosed by heat. Hence we should not be without analogy were we to consider the same thing possible with all other beds or rocks assumed by geologists to have originated in igneous eruption. But it is not enough simply to assume that the limestone beds intermediate of primary strata are likewise of aqueous origin metamorphosed into a crystalline rock by subsequent ignition, for there must have been not only a metamorphosis of structure, but a transmutation of substance, or from whence came the lime?

Water will of course deposit the same sedimentary matter it holds in suspension (especially if it be of greater specific gravity than itself), but how could it have become charged with the sedimentary properties of this limestone rock at the time of its deposition, when there was nothing for it to wash down or abrade but the granite? It will not be supposed the primitive seas could have generated any particular species of matter at will, and yet how else is it conceivable that it could have become charged at particular times and in special places with such matter as this, there being no primary rocks of this character from which water could have eroded the sedimentary matter of the limestone strata? And yet geologists have not told us from whence it otherwise could have come; it must have had the source of its origin in something.

And we can say the same respecting primary deposits in general, for when we find them (including even these limestone beds) passing so imperceptibly into each other, as to make it uncertain where one ends and another begins, we can not understand how the primitive oceans could have possessed themselves of this assorted condition of sedimentary matter in solution, so as to let it fall in formation of so many distinctly characterized rocks, graduating so insensibly into each other. We find the constituent ingredients of the granite, from which the stratified substances are assumed, to have derived their matter disseminated with considerable regularity. What, then, is the aqueous process (had granite really furnished all subsequent matter) by which its fragmentary *debris* were so peculiarly parceled out as to cause the characteristic differences of the stratified rocks? We can conceive of no condition of water, or currents of water, that could by any possibility have effected the several conditions. If it can be supposed that the primitive oceans could have thus analyzed, and separated the several constituents of the granite, distributing them in solution in the particular parts of the ocean where the differently characterized rocks were about to be formed, then there is nothing too much for credulity; and we need not be surprised when we see it assumed that parts of the ocean at particular times had such a preference for carbonate of lime as to procure it from some quarter at the expense of some previously existing rock, situated somewhere, and after its transportation to have let it fall in beds conditioned as we now find it. We can not construe the geological doctrines of the day in any other way than to involve the inference, that all the stratified beds are aqueous depositions of the eroded and broken down matter of rocks previously existing.

Now when we find the beds, and portions of beds, of stratified rock composed of such unequal proportions of the granitic ingredients, and believe that they were derived from that rock, we must conclude something to have separated this matter and sent the several kinds down in their proportions at the relative times and places, as now indicated by their distinctive conditions. The very circumstance of these beds being a severality is evidence of dissimilarity in their constituent matter, but what could have caused this dissimilarity of matter when in contiguity, if all were from the same source and exposed to the same originating or eroding circumstances?

The abraded *debris* of the granite or other rocks could not thus have separated itself; therefore this theory of derivation is reduced to the alternative of attributing the several kinds of matter of which strata are composed to the conduct of the waters from which they are said to have been precipitated, for there was nothing else which could have effected this separation. It will not be contended that subsequent semifusion, to which so much is attributed, could have effected a transmutation of the constituent properties of the matter of these beds, neither do geologists say or suppose that the molecular affinity of the ingredients themselves metamorphosed them into such assimilative conditions as now characterize the several beds. If, therefore, to the conduct of water all this is referable, the whole system must be erroneous, for by what conceivable form of aqueous action could all the several assortments of matter have been derived, assorted, and deposited where now found? If aqueous action is assumed to have originated all the stratified rocks, which we infer to be the prevalent opinion of geologists, it will follow that this water would not only have separated and deposited the several kinds of assorted matter it had derived in greater homegeneity of character, but that it must have had discretionary and discriminating powers by which to apply the proper kind and quantity at the proper time and place, for there are such abrupt alternations and graduated passages of the different kinds as could not have been done by water unless having such powers. And so must it have been for those rocks that are assumed to have been of igneous origin; for had there not been discriminative ability in the igneous fusions and forces, how is it possible to conceive of the subterranean rocks, that they could have been fused and erupted in the times, quantities, and qualities that would have been required for the filling of the fissures with the severally conditioned matter which forms the veins, and in the intrusion of intermediate beds or overlying masses, in all their associations, blendings, and abutments, with strata assumed to have had an aqueous origin?

It is just as difficult to comprehend how all the igneous rocks originated, either in the ejectment of different kinds of molten matter, or its transformation by different degrees of temperature in which it was erupted, as it is to comprehend that the characteristics of sedimentary strata were caused by either igneous or aqueous action. We look upon the assumed origin of both primitive and stratified rock as being a problem of which geologists have totally failed in the solution.

When we contemplate the primary rocks associated with the stratified beds, we only perceive the transitions that would necessarily take place in matter during the earth's formation. . The little persistency in these differently characterized rocks, their passages into each other, their transpositions of place, their distinctive planes or parallels of separation, though puzzling to geologists, are in themselves not surprising, as we shall see. The force of gravity is but the aggregated effect of affinitive energy as a whole, and is the best evidence of its mutual operation among the molecular parts, and is always equally active whatever may be the condition of these parts, becoming more and more effective as they approach consolidation, or what is called condensation.

Hence the period occupied in the metamorphosis of matter from its first energetic impress to its present condition is not to be measured by the epoch of aqueous action, which is so usually assumed to have been the earth's first condition, or of increasing and decreasing temperature, to and from igneous fusion, as geologists usually infer, but comprises the whole time from the first impress of primordial matter until now. The affinitive action of molecules among themselves, in accordance with their chemical constitution, being the first great principle that governs the condition of all substances, must have determined in a great degree the characteristic differences which distinguish rocks from each other. There is no doubt but the formative effect would be much facilitated by a fluid state of the constituents, and in primary times it must have been so without being in igneous fluidity; in such a condition the constituents of substances could the more readily satisfy their affinities, and slowly consolidating from such a state, altogether undisturbed, it would necessarily be of the most perfect crystalline character; and we constantly see, in the imperfectly crystalline structure of these primitive rocks, evidences of a persevering effort to this effect.

The affinities of the molecules of perfectly fluid matter having by that token so far preserved their spherical character by this freedom of mobility, would necessarily associate so as to be perfectly pervious to the pencils of light as already elucidated, being what we call transparent substances, which is always found to be the condition of perfect crystallization, because the pencils of light can play intermediate of the well-arranged molecules. The molecules not only give free passage to the pencils of light, but they have such regularity of arrangement as gives rigorous form to substances reduced to solidity even by compressive deprivation of their atmospheres. The perfection of these crystalline forms, and the truth of their transparency, is the best criterion of the infinity of sphericles having been unembarrassed while uniting in solidity. But let the most perfectly formed of these crystals be broken up and ground into the finest powder, no mechanical pressure can again restore its crystalline solidity or transparency, because the lines of light and molecular derangement would not thereby be recovered from their confusion.

But suppose a mass of this pulverized matter to be situated somewhere in the earth, as other rocks are, and subject to the incessant action of that medium which we have demonstrated to be pervasive of all things, is any physicist prepared to say it would not change its character, and even partially return to its former state?

Chemists well know that all substances are subject to disintegrations and reconstructions of their constituent molecules, and art is at best but a very imperfect imitator of nature, and the process must be prompt, or artificial operators could not recognize the effect. But nature is not called on to perfect her purposes in an hour or a day; her operations are usually so distributed that observers can not appreciate her progress, still it is not the less sure.

Now, instead of this pulverized matter of a once crystallized mass, let us suppose a deposit of heterogeneous particles so mixed up as never to have crystallized at all. No one will suppose that the effect of gravity in its precipitation upon the earth's surface, or its force in fastening it there, could have caused this matter to spread out in a plane parallel with the horizon (as geologists assume the earth's strata to have done), even if the surface on which it fell had been level.

Before the fall of such a body, the force that had given it a substantive character must have caused it to have a center of gravity for itself, so its form would necessarily have been a sphere; and it is easy to perceive what form of extension it must have taken on coming in contact with the resisting surface of the earth. Passing perpendicularly or obliquely would no doubt modify the expansion of such a mass, but under no combination of circumstances could it have been spread out uniformly over that surface by which its progress was arrested.

Now will any one imagine that this mass, with all the chemically elective affections existing in its molecules in perpetual activity, would remain buried in the earth through all time in the state in which it was mechanically deposited? Such a supposition would be absurd, for the affinities of its own matter assisted by aqueous saturation under the constant excitement of the all-pervasive medium in which it is enveloped, would slowly, perhaps, but surely, have effected a progressive separation and assimilation of the incongruous ingredients, and have fabricated them into perfect or confused crystals according with the previous condition of the matter and the embarrassment the formative and affiliating forces had to encounter. These molecules thus slowly but progressively forming a more perfect union, would necessarily occupy less and less space, and the consequence would be, that the substance would not be able to contract longitudinally without causing separation of the matter of the general mass; and the result of these separations, by the affinitive disposition of particles, would be to make room for the formation of crystals or the infiltration of other matter, which would continue to form and keep full these partings of the more primary deposit, so that when exposed to view it would exhibit itself as a rock ramified with veins differently characterized from each other or the rock they ramify, and composed of that for which the general mass had the least affinity.

We can easily perceive that the contraction would form fractures, and that by the rejection of the least affiliating of its particles the rents would be so filled, that in the same rock we should have veins of any denomination, even to clay; for while such fissures were forming for the reception of particles of little general associate affinity, these would find their way to them by their own affinitive force. If the hetèrogeneous particles of the mass had not so far taken a positive form as to be fixed, we should find them, as a general rule, affinitively associating themselves and forming a series of crystals in granular alternations more or less complicated, and perfect in proportion to the condition of the primary ingredients.

This supposed deposit of a heterogenous mass of mineral ingredients that we now find metamorphosed into a granitic rock, characterized by crystals and intersected by a series of ramifying and variously conditioned veins, is in every feature but the effect of affinitive action of its own constituent molecules, operating through the untold cycles, epochs, or ages that measure the duration of a world.

Fire and fusion are not at all essential to the structural characteristics of rocks that are so much more readily derivable from the affinitive action of the ingredients themselves. There seems to be among the molecules almost, if not quite, a verification of the adage, "like begets like;" but even though the transmuting power be denied them, it can not be questioned but that there is such strong attraction among them as causes the social grouping of the several kinds. When geologists discover one of these self-constructing arrangements of crystallization and various intersections, they unhesitatingly attribute the varieties and form of each to igneous action; they say, "that in the first place the crystallization of the general mass took place in its refrigeration from primary fusion." In the second place, the veins intersected by other veins were caused by the subsequent flowing in of fused matter into fissures *somehow* formed; and as often as they find intersections or cuttings of veins by veins, so often do they assume igneous irruptions to have taken place at more or less remote periods, the priority of the veins, as to time, being given to those oftenest cut, and the uncut ones are deemed the most recent of all.

Metallic veins are assumed to be caused by segregation or chemical action; but they do not often tell us from whence came the foreign matter always found mixed with the metals. Clay veins were formed by aqueous infiltration of argillaceous matter, say they, but they are silent as to its source.

Now, it does seem strange that wisdom should bewilder itself in such mystification, when the way to nature's truths is so sure, simple, and straightforward, and the finger-posts point so unerringly as that none need miss the way.

Would geologists only admit that the molecules of matter are able to manage their own work, and patiently contemplate their affinitive conduct as the cause of things in connection with the general whole, they would readily reconcile the phenomena of rocks with the effect of these molecular formations as operating in the strength of their constituent affinities.

They would perceive how these differently characterized molecules could, in process of time, change their positions (in reference to the social relations first affinitively formed), when subjected to another order of circumstances. Why, then, will geologists insist that the matter of which their rocks are made is so mechanically fixed as to be in the same condition under all changes as when they as deposits were first laid down. This is assuming too great a permanency for any part of a system constantly undergoing change; the surprise should rather be that so many of the primary characteristics of such matter are still retained.

Although fluidity is certainly most favorable for change in the condition of matter, still that is no reason why solidity should be regarded as a perpetual bar to all mutation. In the suppositional mass transformed into rock that we were contemplating, there can be no reason assigned why in process of time the most of its molecules may not have separated from their former associations (in conformity with their changed conditions), and again associated themselves so as to produce alternating crystals of their several assimilating kinds, while those particles that were of unassimilating character, or that were so conditioned as not to affiliate in these formations, would either have to be inclosed as unaccordant ingredients in the category of crystals, or be thurst into what chasms were made by general contraction, there to associate with other expelled matter as their energetic affections might dictate or determine. To account for the "primary strata," we have but to contemplate a slight variation of the circumstances affecting the same suppositional mass we have taken as a typical exemplification. The dissimilarity of condition which would cause the matter of this mass, or a portion of it, to be stratified and crystallized would be, that instead of being at once deposited upon matter of the same condition, it would, were an ocean interposed, have to pass through its depths; and in this case the particles would be, to some extent, separated from each other while suspended in the water, and the facility of motion while in this state would assist their assimilation, so that when they settled down upon the bottom, the molecules would not be in precisely the same relation to each other as when they impinged upon its surface. We may suppose at the same time that the affinitive molecules of this last deposited mass (having acted on each other a longer time than those previously deposited) may be less resolvable into perfect forms of crystallization. From the subsequent affinitive and assimilating action of the moiecules of such a mass, we should expect confusion of crystallization and irregularity of granular alternation. The confusion would follow from increasing imposition of restraint in the motions of the molecules among each other, and the inclosure of such unassimilating matter as could find no fissures to enter. We should likewise find the perpetuated effect of the affinitive energy of the mass would be to separate and assimilate the several kinds of its own matter into crystals, and likewise into visibly luminated planes of parallelism, and ultimately into whole beds of dissimilarly associated matter, separating themselves by distinct divisional planes. Thus we perceive that matter might in time become metamorphosed; yet it could only be called an aqueous deposit, from its having passed through the ocean at its full. This passage would modify its relative conditions to some extent, but could not so separate the molecules as to let the several kinds fall in the form of interstratified beds, or the stratified lamina of beds. It may have been the initiative, in most instances, in giving them character, but still very little could be effected by affinitive action in the little time of its passage to the bottom, compared with the same action operating through countless ages subsequently. If matter can separate and assimilate its kinds in the formation of alternating lamina with planes of distinctive subdivision, which it unquestionably has done, what good reason can there be given that the same thing has not been accomplished with respect to alternating strata? The process is identical in the two cases, except that one is on a larger scale than the other. We presume the passage of the one into the other may be traced by imperceptible gradation, from the lamina that forms the enlargement of a concretion the size of a walnut, to the strata that constitutes a mountain.

If this ability of particles to associate themselves in masses be admitted as a fact (and it must be if the unmistakable indications of nature are followed), we need not be so much surprised at finding beds of mixed crystallization or structural character, or to find no traces of stratification in beds at all.

Stratification or lamina is not found in substances where fluidity allows mobility in the particles, and if their energies are constantly directed against the stratified insimilitude to which their solidity restricts them, we may expect to find instances in which it has been overcome, and these are usually designated as igneous rocks. All these circumstances of formation have actually taken place in the primitive or crystalline rocks found interspersed among stratified beds and in the beds themselves.

We regard the granite as the foundation rock, or base on which all the other rocks rest; but it does not necessarily follow that we consider it never found higher than the base of the most primary strata, or that it may not be interspersed among rocks of a more recent origin. We call it the base because it is the termination of strata, and our downward researches have always ended in this rock, which shows at least, that at this epoch of the earth's formation circumstances were favorable only for the deposit of such matter as subsequent action would solidify into granite. This is conclusive from the fact of there being nothing else found but granitic matter, consisting (as physicists say) of but four kinds, either because the earth had not then received the rudimental forms of other kinds, or was not in a condition to render them concrete.

From this structure we now pass into what is called the transition period, when the condition of matter and its formative cause become subject equally to metamorphoses, and kinds began to accumulate. We have demonstrated the constantly increasing pressure of the earth's incumbent envelope, and have inferred therefrom the formation of water, at the accession of each coalescing substance, so that we have in these accessions alone a manifest source of change in the circumstances which would effect the affinitive action of matter. As these descending cometic bodies coalesced with the earth, they would cause much disturbance and commotion, increasing at every repetition in proportion to their magnitude, and the thus augmenting density of the atmosphere and the depth of the ocean.

The molecules constituting the nucleus of these bodies would necessarily undergo great changes as they penetrated the earth's envelope, so that by the time they reached its surface they would be reduced to the condition of the pulverous particles we have contemplated for our model mass, and they would be more or less spread out in heaps. All this would most certainly be the effect of the first principles and progressive efforts of gravity and matter in the manufacture of a world; and it may become as intelligible to every one of us as if we had been present with an omniscient eye during the whole progress of the process.

There being no direction in space from which these coalescing substances may not have come, we surely need not expect the earth's circularity to have been preserved by them in its more primary perfection, now that they could no longer flow down in perfect obedience to aggregated action; for these repeated accumulations would hold every relative position to each other, giving to the earth's surface an aspect of confused irregularity of heap upon heap, parallel with and crossing each other at every possible angle.

We thus behold the aspect and action of a primitive world when the rudimental properties of crystalline rocks were deposited, and behold it more accurately than if our point of view had been from one of these most elevated prominences. Thus contemplating and concluding this deductive deposit of the ingredients forming primitive strata, we perceive that subsequent matter would not continue in the same condition and mixture as in primary rocks, but would become more and more uncertain in character; owing to the unequal magnitudes of the coalescing masses and consequent compression, they would not be equally prepared for the earth's more forcible energy, thus the general mass of deposit would be, to a certain extent, alternated and mixed; but however mixed the matter composing this great mass of stratified matter may have been, still it must have been so subdivided in its kinds as to become the initiative in causing assimilative action to take place most effectually in planes of approximate parallelism, subdivided in many instances into alternating layers of less definitely separated and imperfectly assimilated matter.

The magnitude of the earth's mass being composed of the most energetic nucleus matter converging to a common center of gravity, it would necessarily follow that her envelope would be proportionally accumulative, and in an increasing ratio as these bodies became more and more cometic in their character; for the most energetically composed substances (through the force of their own gravity) would be the first to coalesce, leaving the lighter substances longer in space.

In consequence of these accumulations the earth's envelope became conditioned (by its aggregate of quantity and consequent pressure) to complete the transformation of some portions of the descending matter into water, as we before stated. These accumulations of water would have very considerable effect in distributing the falling matter over the surface of the earth, as it could not attain solidity in solution.

Now these accumulations piled upon each other, and under the influence of the agitations accompanying their coalescence, together with the floods of falling waters (which must have produced some effect), would not be left in assimilated beds of alternating parallelisms in the plane of the horizon. Neither would there be that separation or assimilation of the different alternating kinds that now characterize both the primary strata and their interposed rocks.

This was all left to the assimilating effect of subsequent time, aided by incidental circumstances attending the accumulations, the relative times of coalescence being determined more by the distance traversed than by their molecular character; and the differently conditioned molecules of falling masses would blend each with each in their passage through the atmosphere, and subsidence to the bottom of seas. Surely nothing can be more evident than that the formative affinities mutually existing and acting in the molecules themselves would transform this deposited mass into the kinds of which it was the most readily susceptible; hence we should feel no surprise on finding beds of crystalline limestone, though differing from any matter that preceded it. Can there be any conclusive reason why, among the heterogeneous matter, some of it should not have been more readily susceptible of an affinitive metamorphosis into this new substance, by segregation or assimilation, than into any other substance? We hold it to be incontrovertible, that *time* and the affinity of rudimental forms are all-sufficient for the production of crystallization in all its forms, without any excess of heat or the matter having been in fusion. Now that we have from first principles, and in accordance with the unquestionable claims of nature, demonstrated the origin and circumstances of deposit of the primary strata and all the rocks included, it would be a most inconsistent conclusion to suppose the molecular affinities formed it into beds in obedience to any rule respecting the horizon.

Fluid matter in obedience to the force of gravity, and by being unrestricted in the motion of its molecules among themselves, would necessarily and unquestionably abide by the rule of regular distance from a common center according to the weight or gravitating affinity of the particle. The principle which could cause any approximation to a general rule for the final position of strata, whose deposited matter was not thus fluid, would be flexual inclinations of the deposited substances to the plane of the floor on which it fell, together with the influence of gravity operating downward; this last could have but little effect in the separation or assimilation of the matter of a mass of mixed ingredients.

Wherever the most of one kind was situated, there would be the plane of mutual and more concentrated action, which would constitute what we may call the special parallels of perpetual fixity, by being the initiative in the condensation of forces which assimilate the molecules of contiguous substances, thus constantly tending to the more final separation and assimilation of the mass, and its erection into stratified or unstratified rocks, as the associate forces of molecular affinity might determine, and at what angles these forces could most conveniently effect the process, which may have been from a perpendicular to a plane with the horizon.

We should infer that when this primitive matter on its fall was heaped up into mountains and mountain chains, the central portions would be least heterogeneous, from having been least mixed with the matter of the earth, the atmosphere, or the ocean, or even with each other in the severality of kinds. When the primitive particles of substances were so far fixed that surrounding forces could no longer effect their affiliation in the forming mass, they would either be inclosed within or rejected from it in search of fellow-affinities, in other forms of association. When the particles are so situated and separated as to associate themselves into crystals or crystalline rocks, the perfection of these will depend on the disposition made of the incongruous ingredients. They will generally be found thrust out into veins or stratified beds, or between the more perfectly crystalline portions of such beds, in which case they have caused the confusion of such crystals, and caused the rock to assume more or less a fragmentary aspect. Crystallization is the form all solid matter would take if the rudimental molecules were of the right size and order, and were free in their motions, and this does and has taken place just so far as time and circumstances have allowed.

With proper regard to these general principles of deductive investigation, we see there is nothing found among formative rocks that the circumstances would not lead us to expect, for the whole system seems to have its root in the granite, and to have made gradual transition in accordance with constantly changing circumstances, these circumstances necessarily originating in the general aggregative affinity of its own atoms.

We found the effect of this affinity in the very inception of physics to be the forming of all affected matter into a series of radical forms or infinitesimal sphericles; and whatever order of energy they might have had, they must have been, as a general rule, indestructible and impenetrable by each other. The atoms congregating according to their gravity would constitute common centers round which they would revolve, so that no subsequent association could readily change the effect of this affinity.

Gravity would continue to act on these forms in its aggregate capacity, inducing aggregates of these rudimental forms, constructed in every particular like the first, only the constituents would be no longer simple atoms, but ultimate molecules, or an association of these initial forms. The circumstances attending the formation of these secondary forms could not insure so effectually their perpetuation; for on their coalescence with each other their combined energy would cause their compressive confluence round a common center, in the direct ratio of their gravitating affinities, as with the simple atoms of the first forms.

This process of the analogous formation of spherical substances propagated by gravity, and proceeding from primary molecules to solar masses, would have been the same, only for augmenting magnitudes causing corresponding pressure upon the compound molecules, so they would be perpetually subject to reduction, disintegration, or reconstruction, as the changing vicissitudes might determine. The gravitating attraction being the only force effective upon matter, its application to the ultimate atoms and its energy of action never having been modified from the first (there always having been in nature as much force as there now is), circumstances could not have changed, only by its concentrating effect in aggregating the atoms of its attachment; and this process of aggregation could have only been caused by the infraction, or rather inequality, of its universal balances as first applied. The time required for this concentration must have been incalculable; hence we need not expect at any particular epoch to find sudden or decided dissimilarity between the constructive characters, such as that which now so far marks the rocks as to enable geologists to individualize or determine their classifications or groupings, but such must, in some measure, have been caused by the severality in condition of the descending bodies.

These, in the first place, for an immensity of time, must have been separate bodies severally circumstanced in their molecular relations and affinitive forces, which by subsequent conjunction now form the respective portions of our earth's upper crust. This molecular condition of these several bodies, as received under the vast pressure of the earth's exterior envelope, must therefore have had no inconsiderable effect in making these primitive rocks what we now find them to be.

The mutual affinity of matter from its first energetic impress to its final solidification into substantive form must have been in constant activity, pushing forward the physical development to its finality. Therefore the affinitive energy of the matter of cometic bodies, which in time were to become accessions to the earth, could not have remained inactive, but must have made molecular progress agreeable to the affinitive forces residing in themselves respectively, and regulated by the amount of pressure imposed by the gravitating attractions of their own common centers. The crystals and forms found in the granitic formation and transition strata present the best possible evidence of progress, and that their constituent matter as received was the best conditioned for their several forms of structure, even before it could have acquired a character needing to be igneously reduced, because of never yet having attained solidity. In place therefore of granitic rocks (and others assumed to of igneous origin or metamorphoses) having undergone that arbitrary and inexplicable process not required, we find them to be but progressional insertions in the great physical catalogue inscribed in the most harmonious characters and progressional order, as necessarily deducible from the primary application of gravity to the ultimate atoms of matter, whose incipient and all-potent action we now find producing another phenomenal expression in the all-important formation of water, a substance now becoming highly essential and effective in giving character to the condition of subsequent things.

Its presence was not required till the aggregating mass of the earth had been reduced to some degree of solidity, and those circumstances which caused its solidification would be most effectual in reducing the components of water from their gaseous condition into the new form of water; so that as the general fluidity of matter became less and less practically effective, this other was as progressively substituted.

Thus we realize in retrospective vision the formation and fall of the first waters that moistened the thirsty earth, whose absorbing capacity would be likely to appropriate to itself this now forming product of its pressure. A vast quantity would penetrate the previous deposits before they would become saturated, so as that it could accumulate on the surface. The great basins formed by the irregularly disposed solid substances would then fill up because of the constant accumulation. This formation of water would go on with every accession of matter made to the earth's surface, each in turn contributing its vast cometic atmosphere to the earth's envelope, and its formation which would thereby increase the pressure, so that part of its own contributed matter would combine in the form of water.

Experience proves, as already noticed, that relief from atmospheric pressure goes far to effect the resolution of water back into its components, proving that pressure is an all-important principle in the determination of this substance. General circumstances must have been much as they now are, before the elementary properties of water would condense down from their gaseous state so as to combine in the formation of a liquid; their extreme readiness to depart from this concentrated condition is good evidence of the fact that this is a forced state.

Experimentalists decompose water at will; still we never find philosophers intimating that nature does any such thing. From any observation they make on this subject, we are left to infer that there was so much water made, although they say not how, and so much water there will remain; they, as well as others, are aware that it is readily resolvable into insensible vapor. But are they indeed certain that its components always continue their combinations ready to return to a liquid state on condensation and without loss? may they not, when in this invisible state, at times, and under certain circumstances, separate and associate themselves with other forms, such as were affected by their affinities before they were forced to the formation of water?

While we do know that water is resolvable into vapor by heat, and this vapor reconvertible into the same quantity of water as before by condensation, we likewise know that this is ascertainable by confinement of the vapor within some competent inclosure, while its character and tendencies when free is to disseminate itself among molecular forms of the same density with itself. Will any one say on what philosophic grounds its constituents would continue their preferences for each other, under all circumstances, in place of returning to their former gaseous attachments? The formation of water being a forced state of secondary character, must unquestionably be subject to decomposing circumstances. Why, therefore, should we infer for it an indestructible character? or, rather, why suppose it unsusceptible of such transmutations as the economy of nature requires? Do we not often find it so disguising itself in association with such substantive forms as to be no longer visible as water, but a constituent part of their solidity?

We find water and atmosphere the most important parts of animal and vegetable organisms, as furnishing the materials for their construction; are they not then metamorphosed? Water, we have seen, might have been more or less in quantity, agreeable to the circumstances by which it was originated; and there may now be more or less of it in its primary condition, or as first formed, just as circumstances may have contributed to its transmutation, or as substances in assimilative construction may have required and appropriated its components as constituent elements of their order of construction.

There can be no consideration of greater importance to the physical inquirer, than the fact that all the activities in and on the earth are caused by the molecules of fluid matter mutually metamorphosing their associate relationships by the force of disturbing circumstances that surround them. When matter is reduced to solidity it parts with its principles of activity held in common with more susceptible substances. But it is at the same time subject to be operated upon, by being constantly exposed to pulsatory action, because, as before stated, solidity can only be by simple points of attachment, and therefore permeable by the all-pervasive fluid that keeps them together and that pulsates activity upon all things.

This nervous fluid of nature, by which her muscles are moved to action, connects all things with all things, from the most subtile to the most solid, from surface to center, from the most minute point to the mightiest fabric, and binds together all physical forms that the affinities have fabricated, by a force far surpassing this direct and formative affinity of their own constituent molecules.

Had it been otherwise, and the formative affinities of sensible substances had been the sole arbiters of their respective conditions, every formation would have been a finality terminating in an eternal rest.

But when we consider these formative affinities as effective under an independent force of infinite elasticity, susceptible of high excitement, we perceive that any modification of this measureless tension by such excitement would more or less effect the terms on which molecular forms were fabricated into sensible substances. So that in place of the permanent stability which constituent affinities would in themselves impose, we have a life-like activity in sensible substances, by the simple modifications of a medium really forming no part of themselves; and though unseen, and measureless in power, still infinitely susceptible of modification by simple agitation of its intensity of tension or common aggregate of all power.

Now when we contemplate the effective modifications of this very force that sustains the integrity of forms, minute though its pulsative vibrations may be, and insensibly delicate though the nature of its operations must be upon particles of matter mechanically deposited in strata (without regard to the social affinities of the molecules themselves), still, when operating through the long vista of ages since the first deposits were made, and particularly when aided by the auxiliary influence of aqueous matter, thinking of all this, we must be convinced that its continued effect would be to modify and change these deposits by its agitation of, and insinuation between, molecular attachments having only a mechanical tenure, and these molecules would then be free to fraternize in more affinitive and assimilative associations, though still considerably embarrassed; and though some of these substances seem to have undergone entire transmutation in their material or specific character, this should be the source of no surprise, for we find every sensible aspect of matter is of a derivative character, the creature of circumstances, and already of a metamorphic character in every condition in which our senses recognize it. And although mankind may be unable to effect the transmutation of what are called its elements, that is no proof that they are unconvertible by nature's processes.

Chapter Twelve.

Kinds of Matter—Metamorphosis—Systems of Rocks—Porosity of Matter—Aqueous Agency—Pressure of Impact—Animated Nature—Silurian System.

Kinds of matter are but physical consequents, as all other phenommena are, though not so easily rendered back into the realms whence they came. The farther matter has removed (by its molecular combinations) from its primary state of existence the more susceptible it will be of artificial retrogradation; but this process of retrogradation can not be pursued to any great extent before it reaches our limit, and that is very far short of primitive atoms, to which indeed it is questionable if nature herself ever now descends; but she unquestionably descends far below our limit in the dissolutions and distributive recombinations of her molecular forms.

When the principles of material metamorphosis or transmutive effect of affinitive action of molecular constituents of contiguous ingredients, mechanically mixed, become well understood and admitted as a measure of physical action, together with the effect of the operative circumstances above signified, then it will be comparatively easy to explain the geological structure and character of rocks in general. Consulting these principles of action, therefore, we must be convinced that the transposing, transforming, and transferring effect of the affinitive action of matter must have been more and more embarrassed in its operations as the process of accumulating the materials for stratified rocks progressed; for the most energetic molecules would become more and more removed from their fluid condition, and consequently impeded in their motions toward a formative finality. In the transition strata we find the passage to have been *from* such condition as admitted affinitive crystallization to such as precluded the possibility of such structure (without the intervention of fusion or some similar means). There is in all the rocks manifest evidence of the assimilative efforts and effects of these affinitive forces; for many of the beds and intersecting rocks are altogether of a crystalline character, though in the usual construction they are so made up of the alternating kinds and crystals in larger or smaller quantities as to be readily mistaken for the fragmentary accumulation of degraded portions of previously existing and broken-down rocks cemented in all the fragmentary confusion of alternating kinds and crystals, seeming as if promiscuously mixed up, and more or less massive in their proportional parts or persistent in their specific characteristics.

Now all the structural irregularity characterizing the transition strata (and so confounding to geologists) is evidence of assimilation and association, by the effect of the constituent affinities upon contiguous particles of the general mass; these affinities being embarrassed and modified in their effect by the mechanical pressure and crowded positions of the rudimental forms originally mixed up, and against which they would have to contend when fabricating structural forms, which would necessarily cause them to seem in confusion, what else but the affinitive forces resident in the particles of these heterogeneous deposits could have caused their divisibility and re-association in crystals or concrete gravels according to their own rules of relation? What but these intestine and infinitely diversified forces could have so effectually pervaded every rock-originating mass with rules for subdivisional beds, dykes, or veins? The molecular forces so effectual in the formation of rocks or other substances are usually, but very erroneously, regarded as so many separate and distinct orders of power, when in reality all the forces of nature are so analogous as to have originated in the same root, of which gravity is but the prominent expression or aggregate idea; but as, unfortunately, the term is usually considered as only applicable in the aggregate, it is deprived of the extensive significance to which it is justly entitled. It should be considered the source of every physical power of formation, from the erection of rudimental molecules to the revolution of systems, and equally effective for all, as well in the atom as in the aggregate. While the mutual affinity of atom for atom aggregates the sensible power which we call gravity, the same affinity of atoms erected the rudimental molecules in all their united severality of relative energy and magnitude, and these, in the multiplicity of their combinations, are the chemical affinities so called, all being but different terms designating the several effects of the same force.

This affinitive force, while operating among the molecules of matter mutually, must very much modify the measures of its own formative effectivity in producing the minor phenomena of nature by the centralizing effect of the parts. But by this same centralization of force, and its effective pressure, nature has produced the solidity of substances in all their gradations. Thus we see these mutually affinitive forces must have always been more or less embarrassed in their responses to the constant mutations of pressure and solidification imposed. And it must be obvious that the formative relations of solid and compressed substances would be unable immediately to reciprocate the changing expression of modifications in these conditions. This accounts for the matter of rocks remaining confusedly mixed up in disobedience to the mutual affinities of their constituent forms mechanically crowded together in heterogenous masses.

Were this matter by any means resolved back into its primitive fluidity, so that its fundamental molecules could have motion among themselves, their affinities would the more speedily satisfy themselves, so that their reconsolidation would be in all the regularity of crystalline rock, with the several kinds associated in veins or variegated aspect. This, we find, has in many instances been more or less effected by the disintegrating excitement of the earth's pulsatory action as propagated in that all-pervasive fluid, operating through untold time, which we have found to be the source of all the lifelike activity animating the earth. This activity, exciting the ultimate constituents to seek for more befitting associations, has caused a molecular metamorphosis of the deposited matter of all rocks, but more conspicuously among those stratified beds of remote antiquity, and especially in that portion least affected by the force of solidifying impact, or, rather, such as had undergone the least change from its original condition.

Now can there be any reason why these regular operations of nature could not quietly but surely have effected all the grades or gradations of rocks, from the most perfect crystalline type to the most mechanical mixture, and that, too, without the agency of those revolutionary forces and fires which theoretical geologists make the foundation of their faith.

Practical geologists undertake, for their own convenience, to divide and classify into groups or systems the great series of stratified rocks, from the granite to the superior tertiary inclusive, but in this attempt their divisional plans are necessarily artificial, arbitrary, and uncertain; for when taken as a whole, and as constituting the earth's envelopment, there can be no definitely divisible plans in the order of geological progression, as induced by the ordinary process of nature in the accumulation of the earth's matter. We have already seen by what measures she acquired the greater portion of her magnitude, and we see no reason to contemplate any change of process in the acquisition of what was yet to come.

The reception and disposition of external substances upon her surface would unquestionably become less frequent and of less uniform distribution as the aggregating process approached its completion, so that the intervals, in many localities, have been extended till the condition of matter was so far changed as to make these periods geologically conspicuous or well-defined by systems being imposed on systems of less similitude, while other localities may have had more extensive and progressional contributions. These well-marked lines, when found to prevail, may enable the geologist to designate the divisional groupings of that particular district. But in other localities such intervals will be filled up by such series of rocks as make good the progressive connection in their more continuous order. Thus there may be many instances of very decided dissimilarity in the character of the several groupings as they succeed each other in the order of position, and in the monuments which mark their relative epochs and abrupt transitions; but the whole surface of the earth being the receptive platform, and this platform in perpetual motion, descending substances having no determinate direction in common, but floating in as it may have been from any possible point of space would impinge on this platform without respect to each other, and without any uniform order of superposition; by this it will be found that different localities need not be expected to afford the same geological systems in common, or even their equivalents.

All the rocks or systems of rocks may, in their turn, be absent or present, as interstratified members of the general progressive series, of which geological observation furnishes abundant evidence; for there has been found, in some instances, vast deficiencies, so that even the coal measures, in some locations, are resting immediately upon the primary rocks, all the usually intervening strata being wholly absent. Again, in most places, we find the missing rocks, and not unfrequently in large quantities.

Although all the different orders of stratified rocks in the whole descending series, and even the granite itself at times, are exposed to the surface, this can not be regarded as positive evidence of the original absence of those usually superior in place, for they may have been, and unquestionably often are, carried off by denuding processes. In the various accessions of geological matter, accumulated through countless ages, we seldom find in any one exposed district the whole series of progressional deposits piled one upon the other, as they from time to time impinged upon the earth, for such a general disposition comprehends the whole surface, while the several impingements could constitute but comparatively small additions to the respective districts on which they fell; and this without any regularity in their progressional superposition as a whole. Their coalescence, comprehending the whole of the earth's surface, could have had no reference to each other's descending motions while in space; while the ever-changing orbital position of the earth, together with her rotative position of [illegible] surface, would have exposed the several sections to the incident impingement of descending bodies, from whatever point of the heavens [illegible] may have come; so that extensive districts may have failed (thro[illegible] long epochs) to make any accessions of the matter of which rocks [illegible] made, while other localities were in the same time accumulating la[illegible] quantities. Thus it is that the same geological series of rocks fo[illegible] in one district are missing in another, and that the different regions of the earth are so geologically different. The accumulations in different districts would differ not only in quantity, but in constructive quality; for, as before stated, the descending mass would be modified by the affinities of their own matter in the space through which it had passed, and by the time taken in its passage.

Contemplating kinds of matter, as conditional sequences in progressional development, we find that up to the epoch of granite accession inclusive, the aggregating forces and affinities could have fabricated no forms except such as were conditioned for crystalline solidity; for we find till then but the four ingredients of granite alternating with each other in crystalline granules, while no other solidifying form has any sensible representative.

This shows there were then but four forms of constituent particles or molecular conditions susceptible of rendering themselves sensible by the further formation of affinitive crystals characterizing the different varieties of that rock.

Now, though we find the legible record of but four kinds of matter subject to solidification, yet the coloring and clouding and changing expression of the granite show the dawning of an epoch in which varieties of matter and its multiplication of kinds was in progress of increase; for, in the succeeding deposits, we find matter so differently conditioned, as to afford conclusive evidence that matter in general was undergoing progressional metamorphosis or transmutation of character.

It must have been by this progressional metamorphosis that even the four ingredients of the granite themselves had existence; for the several kinds, we must remember, are but conditional adaptations of molecules to the circumstances as enforced by their own energy, and therefore but so many expressions of the same force, as differently conditioned.

Had the forces been sufficient (during the period of granite deposit) to have fashioned matter for any other formation, there would be some record of it remaining. The almost imperceptible gradations from granite to all the primary rocks, are geologically traceable when the proper sections are consulted. Mixed with the simple ingredients of granite, the primary strata are found to contain, in some quantities, more or less of the intermixture of metamorphosed matter, which the simple ingredients were unable to assimilate, and which has caused, as before observed, that confusion of crystallization that has misled the speculators in theoretical geology to consider them fragmentary or broken-down rocks, in face of the fact that the primary rock from which they are assumed to have been eroded had no such intermixtures of matter, enlargements, and disproportions of the alternating kinds of the granitic ingredients, even to their entire separation, as seen when the strata is composed of but one of the granitic constituents. This could not have come from any fusion or semi-fusion of the broken-down ingredients of granite, for it would be absurd to suppose that such heterogeneous intermixture could have been so metamorphosed by heat. We often find beds composed exclusively of quartz or mica, and how could the one ingredient have been separated from the broken mass, and the others so effectually discarded?

As rocks are not to be regarded as original principles, their components must have existed before themselves. There must have been a time before matter was so consolidated into such rocks, and when its components, by their own affinities, constructed the different kinds of rocks from far different conditions of matter, therefore a time before there would have been any possibility of a breaking down into fragments. We hold it altogether absurd to suppose there can be any force whatever in physical nature but such as is derived from the simple affinity of atom for atom; and that must have first caused the solidity of substances before it could have generated conditions effective of their destruction. Hence the character of all force is so analogous as to be traceable from one form of action to another; and the slightest reflection will convince us that this simple affinity, in its incipient operations, could not bring the forms of matter within our sensible recognizance at all, much less into the solidity of rock. But however remote from sensible appreciation the rudimental forms may have been, their concentration in the aggregation of a world's material must be proportionably great, and in the progressive aggregation there must have been every grade of pressure applied upon her nucleus forms.

And were the sphere even now wholly fluid, the central molecules would be subject to the mighty pressure of the whole mass, while those on the extreme surface, being but simple molecules, and of the least energy, can only be subject to such infinitesimal pressure as is imposed by their own constituent atoms. So from the center of our solid earth to its farthest fluid circumference, comprehending the greatest and least expressions of power, there must be every intermediate gradation of force. From our situation so far from the common center, we escape much of that compressive power imposed on it and intermediate matter.

Our position is far from being an external one, though situated at a surface; that surface is only where compressive forces become ineffectual in forming the more lightly affected matter into solid substances, or those that are sensible; but that does not prove that this may not be an intermediate position, exposed to the pressure of a depth of fluid matter energetically effective of gravity, and many times the diameter of the solid earth, and perhaps equal in gravitating impact to all the intermediate matter between us and the earth's center. This pressure of impact and its fluid medium of force are in every respect the most important principles in nature, for only under their influence can molecular affinities be effective in the formation of sensible things; for did not this power condense them into solid molecular particles, thus giving them power to construct themselves into the skeleton framework of solid substances, there would be no more consistency to our earth than there is to a comet, and we may safely say not even that. And were it not for this skeleton framework of solids, constructed into cellular compartments, permeable by this very pressure from which alone solidity could have originated, all the matter of the earth susceptible of solidity would have collapsed or have become so condensed that there would not have remained the first infinitesimal interstice among the whole mass. What proportion this condensed or really solid matter would bear to the earth's present bulk we will not undertake to name. Sir Isaac Newton, or some one, has given a supposition on that subject if we recollect aright; and though we do not undertake to substantiate the idea, yet from the legitimate facts and inferences deducible from which we conceive to be the nature of the case, we do not hesitate to say there must have been a time in this world's progress when her whole solid nucleus was not larger than an orange; and as she accumulated her matter so would this center increase its proportions, and that in the ratio of compressive increase, the sensible surface being ever the solidifying parallel as caused by prevalent pressure, because of the progressional extension of the mass propagating a proportional increase of pressure and consequent increase of the sensible nucleus. The mean of this pressure is found to have been measurable throughout most of the aggregating era by the structure and solidification of only four kinds of molecular forms with their crystallizing susceptibilities, these being all we find in the great foundation-stone of the geological edifice, so far as it is penetrable.

But the superstructural series assumes a more complex character as it ascends, on account of the pressure becoming proportionally greater than was only required for condensing the four kinds of forms, so their affinities could ultimately form them into crystals in the construction of granitic rocks. This increasing pressure beyond its usual proportional amount of solidifying effect must have been a consequent of coalescing bodies being in their magnitudes more and more made up of less energetically affected matter, necessarily causing the compressive envelope of the earth to increase in greater proportional ratio to her solid nucleus than it had hitherto done.

Under the effect of this increasing pressure the molecules become gradually less fluid, so they would no longer affiliate in the form of crystals, but run into combinations of consolidated particles that were often too obdurate to assimilate with the constituents of any forming a crystallized body.

The first evidence of this is found in the irregularity and capacity of the granulated crystals themselves, they becoming more and more confused in their forms, and irregular or enlarged in their individualities, until whole beds are found almost exclusively formed, first of one, then of another of the properties common to the granite, whose irregular crystals are mixed up with other and newer forms of matter, seeming in a great measure as if but mechanically constructed or compressed. All these pass into each other, and into more primitive rocks with which they are associated and on which they rest, so that it is often inappreciable where one ends and the other begins. We have no cause to calculate that the same formation of deposited matter should be extensively continuous in any plane; they must pass by insensible gradations into each other, for it would be absurd to suppose that each distinct form of rock could have preserved its own specific identity up to a bluff abutment against the other. And this progressional passage must prevail to some extent in vertical ascensions, or the passage between primary and stratified rocks; and in the stratified beds themselves we find the gradations continue from one into the other. But this is not to be considered a constant rule when the affinities are affecting matter perpendicularly to its planes of stratification, for in these relative directions it must have been that these very affinities formed the planes of separation, by so characterizing the several beds that they are altogether different from each other; the several strata being separated by well-defined divisional planes, could have only been effected by the affinity of their own constituent matter, and not by any form of its mechanical precipitation.

In this direction we find no nicely graduated passages of the stratified beds into each other, as in longitudinal directions, because the affinities have been sufficient to separate and assimilate the several kinds over such inconsiderable spaces as are occupied with the several strata imposed on each other. The relative thicknesses of these rocks in any series have no reference to the quantity of matter of this kind or that, as having been deposited at one or another time, as these alternating beds seem to signify, and as geologists suppose; for these thicknesses are only to be regarded as the measure of quantity in the general mass, which the affinities could most conveniently assort into this form of structure in the alternating paralellisms of their several kinds. These molecular separations, associations, or assimilations could not by any possibility have been effected by any process of promiscuous deposit, but must necessarily have been in by far the greatest measure the effect of affinitive action operating continuously through inconceivable time upon a mass of heterogeneously deposited matter, and ultimately forming the rocks we now have.

While following this effectual system of inductive philosophy by which we have thus far found our way successfully, we certainly see every reason to be well satisfied with the formative affections of nature, or, rather, we should say, the affinity of matter in its phenomenal expressions, and we have found no occasion for the conditional forces of fire and flood 'to fashion matter to their special measures of activity. In the formative affections of nature we can realize no revolution, unless the terms mutation and revolution are synonymous, for a revolution of nature would imply a revolution or mutation of nature's God. The theoretical idea, therefore, regarding the origin of the earth's stratified crust being either from the destruction of rocks by the force and friction of water—its transporting and depositing powers—or their fusive irruptions by fire, may, we affirm, be regarded as measures far too monstrous from which to have made a world. It is worse than nonsense to name igneous action as having been an instrument in operating the primary processes of nature in any general sense, for this very action can only be induced by conditions in which the processes of nature have been the most effective. Igneous action is now a very essential agent in works of art, and it is to some certain extent induced by nature for the speedy transformations of substances that have attained solidity, but it was not needful before matter itself had acquired a substantive quality from which it could be reduced; and while matter remained in its primitive fluidity, it certainly must have been as much in obedience to its own affinitive forces as any degree of igneous excitement could have made it, for in this state neither art nor nature could require its igneous reduction. When we consider temperature in its true character, we must regard it as the simple disturbance of the affinitive forces of a fluid subject to vast compression, and consequently of very acute elasticity, showing a tendency to its restoration to perfect rest, though never for a moment entirely still.

Could motion in this fluid be for a moment suspended, nature would at once be dead, which event is admirably obviated by the peculiar system of circumstances heretofore contemplated as result-ing from the perpetuity of planetary motion and the constant excitement of this all-enlivening medium. This medium could no more have been a special and immediate erection (as a finality) than were substantive forms of any character, but must have passed into being by the same progressional process of development as other substances, and in this progression it would necessarily become more and more effective by its accumulative force of compression, as the affinities of matter were effecting such solidification as needed the intervention of an agent susceptible of being excited into such intense activity. Had there been, no such medium pervading all other substances, and endowed with an excitability which could cause mutation of forms, the molecular forces of more energetic matter would inevitably have determined nature's eternal rest, for their active effectivity is only induced by the action of this highly excitable substance.

In this we see with what admirable provision the very compressive medium (which otherwise would have compressed substances into the steadfast rigidity of death) prevents its own effects by the imposition of this pressure upon itself, making it a medium susceptible of all life-sustaining excitement by the tension of its own constituent nature. This substance so susceptible of the affinitive disturbance of its own matter, and so well calculated to cause agitation in all else, and now so essential an agent in the active economy of nature, being accumulated after the manner of all other material substances, would become effectual in the ratio of its requisition.

External bodies concentrating and coalescing with the earth being less and less dense, as the aggregating process approached a close, would contribute more largely to the envelope, and thus facilitate its susceptibilities for the excitement required by the progressive economy of nature for this form of action. But this falls short of the igneous excitability so much insisted on by theoretical geologists, for such a high rate of action among fluid matter could not have been required.

All has to do with all in the great scheme of nature, and nothing in her mensuration being either too little or too much, we may very properly infer that the calorific principle would come into requisition in the exact ratio in which its susceptibilities of excitement developed themselves, and we perceive this could not have been required only by matter assuming solidity under the increasing pressure of this very excitable medium. Aqueous agency is another very important principle in progressional development, and unquestionably highly essential in the phenomenal processes of the geological department of nature at a certain stage of the world's progression, and when stratified structure mostly prevailed, but certainly not to the extent usually contemplated in the origin and disposition of stratified matter. No one will for a moment suppose water was an independent creation; it, like the calorific principle, is to be regarded as only another expression of progressional development, one more link in the chain of continuity, the creature of causes *à priori* of its production. We have already deduced the epoch of the incipient formation of this substance to have been during the deposit of the granitic materials that are immediately below the stratified deposits, and there is no evidence of its activity or transporting effect until these primary strata began to be deposited upon the granite. But at that time an undoubted change took place in the condition of things and conduct of matter, which could no longer continue undisturbed—the crystalline granulations, as in the rock on which these strata rest; but subsequent deposits becoming more and more confused as being mixed up with other forms of matter in the stratified order of unassimilating sorts which supervene, and which certainly affords undoubted evidence of the existence of water more than sufficient for the mere saturation of matter, the same augmenting pressure which had by this time become sufficient for the formation of water must have had a corresponding effect in transforming the character and combinations of more energetic molecules, as evidenced in the intermixtures of unassimilating matter and confusion of crystallization; likewise in the structure of the components from which considerable beds of limestone have been aggregated, we will find that this product could not have been formed until after the existence of water.

Now, although this is a new substance, it does not follow that it was a new kind of matter; we have already seen that matter in the abstract could have had but one simple characteristic in kind which could not, in consequence of its immutability, have ever extended into a plurality or kinds of its intrinsic character. Of material forms and their combinations there may be an infinity consequent from the affinitive aggregation of united energy; but of the material infinitesimals themselves there can be neither change nor variety, therefore the kind of ultimate matter constituting the new substance of lime must be precisely the same with that of granite or any other substance, that is, so far as respects simple materiality. The gradations of energy in matter would necessarily construct it into dissimilar molecular forms; so in the limestone beds the molecules of matter assumed a new relative association, the result of which was the form and molecular association of these limestone ingredients into a rock, which as a sensible substance was new, and unlike any other that preceded it, and therefore had become another kind of matter. But there was still no change of the material character itself; that in its simple state remains unalterable, while sensible substances in infinite varieties become the necessary consequents of molecular combinations. These combinations being the creatures of crowding and complex circumstances are constantly subject to change. Circumstances therefore that are new are now the cause of such combinations as originate this new form of substance; hence it is we begin to have the primary limestone beds in place of the granite and rocks of a kindred character that preceded.

The most important cause of these changes is the constantly accumulating pressure of impact of our earth's envelope, which not only determines such combinations as can not construct the crystals of granite, but likewise condenses fluid substances dissimilar in character, till they combine in the form of water, a substance likewise entirely new to the earth at this time; but how many insensible combinations and recombinations the molecular constituents of water may have had before they associated in such a formation is unknown, but we infer there may have been very many, both in this and other substances.

When we consider the lightly affected matter with which the more energetic molecules would necessarily surround themselves, when free from compressive impediment, we must be aware that something more than the immediate effect of their own constituent energies must have deprived them of this privilege of appropriative association before they could have been caused to combine in a substance so near solidity as water; for the immediate energy of the constituent matter alone could not have formed such a substance as this at all, much less more sensible solids.

If the molecules were left to the unrestricted exercise of their own energies, they would surround themselves with such atmospheres of lightly affected matter as would render any substance insensible, and nothing but the compression caused by the combined energy of all operating to a center common to all, could so divest the most energetic molecules of any substance of their molecular atmospheres as to enable them to combine or associate themselves into the formation of sensible solids of any kind.

We therefore perceive that as this pressure accumulated, matter would assume different conditions of formative character in accordance therewith; and we may readily trace the effects of this process of change progressively upward in the geological order of superposition. The first positive departure from granitic ingredients and structure are the limestone beds; the next is the more progressive passage of crystalline forms into clay, which can no more be considered as original matter than the limestone; it is only another form forced on the molecules by constantly increasing pressure, which incapacitates them for a further continuance of the crystalline form.

Indeed, the force of pressure is now becoming such as to condense (as we see by the clay) many of the molecular forms into solid and sensible particles, so that they are no longer soluble and long-suspended in water, but now mix in muddy obscuration, from which gradually to subside by the effect of their own specific gravity.

With the deposit of this metamorphosed form of affinitive matter progressively terminates the system of what are called primary deposits. And here the silurian system or equivalent groups commences; that is, at the introduction of this argillaceous deposit these two systems that are assumed to be crystalline and mechanical pass imperceptibly into each other. This silurian system of associated beds, by this connected passage from the primary rocks, and from being extensively developed in many areas of our earth, besides that from which the system takes its name, renders it of much geological importance, besides being that of an uninterrupted progression from the granite into rocks that are assumed to be altogether mechanical. In this system we find not only the continuation of limestone and clays, but we find the forms of matter still undergoing change, so that its particles are no longer the impalpable constituents of clay or of limestone, but are becoming more and more coarse or arenaceous in character, until vast quantities assume the condition of sand.

In this series of rocks, these new forms are found to pass insensibly from the impalpable particles that constitute clay, to beds of coarse, granular ingredients; but these formations of sand are no more the fragmentary ingredients of former broken-down rocks, than are the particles of limestone, clay, or crystal; each and all are but the forms forced on the molecules of matter by affinity and pressure; and they are all so associated and interstratified, even including crystalline matter, that there is hardly a form in the composition of rocks that has not here its representative, and without any need of fire or friction of water for their source or formation.

These alternating beds are not to be regarded as so many accessions made to the earth at so many different times, and of so many different kinds or conditions of matter, all assorted and associated as we now find them; for no immediate process could have produced this result of superposition in the respective kinds of stratified rock.

How much was deposited at a time, and how long the intervals between the deposits, we have no means of judging, but we are sure there were intervals, and many of them of long duration; we learn this fact from another important circumstance, viz., that even so low down in these deposits as what is sometimes called the Cambrian system, time and circumstances had at this epoch not only rendered conditions favorable for the formation of lime, clay, and sand, but likewise for the inception, propagation, and development of an entirely new order in nature, and this was by the association of vitality with certain organized forms of matter constituting the dawn of animated nature. It has been, and still is, strongly questioned, whether there is any possibility of tracing back this order of animated nature to its original germs or first forms of organic being. By the inductive process of research usually pursued, we should say there is but little probability of deciding conclusively this question; for by inference we should not be justified in the supposition that the seas and lands of even the earliest epochs of geological chronology were silent and unpeopled wastes.

This same system of analogical research assumes that at least all the stratified rocks, of whatever antiquity, are composed of sedimentary matter and fragmentary parts of ground-up worlds; therefore we should say, if the seas holding this sediment had been teeming with living beings, both animal and vegetable, we could not expect to find any trace of their organisms after the metamorphic action to which this system of research assumes them to have been subject had taken place. The myriads of centuries since the deposit of the primary strata, and the assumed metamorphosis to which they have since been subject, may well be supposed to have obliterated all traces of organic forms, had any ever existed in these early ages, and have been so subject to destruction.

While such are the uncertain inferences to be drawn from the usual system of inquiry, making the absence of every vestige of organized beings at that epoch no proof of their non-existence prior to that period, or the assumption of such a metamorphosis of the monuments by which they could have been recorded, as would prevent the transmission of any trace of them, this must leave it still an open question whether they had a previous existence or not.

However prevalent the idea of a beginning may be, there is in this usual system of inquiry no possibility of being made sure of it, or of approximating any starting point for nature's organisms; for how can we infer any beginning if the origin of *all* rocks are referable to the matter acquired by the grinding down of others previously existing, which, so far as we can see, seems to be the prevalent idea.

This manner of interpreting geological records opens the way to no other conclusion than that organisms may have always existed, or at least since the assumed creation; for it implies that the world in its entire magnitude and measure of forms was made at once, or it must have existed forever; otherwise this analogical system of reasoning on the relation of things would be of no use, and altogether inapplicable with reference to periods remote from each other in a progressive system of the world's development, and must lead to erroneous conclusions where conditions are so different as they are found to be in the geological chroniclings. What analogy can there be, for instance, between the present time, with a fully developed ocean and atmosphere operating constantly upon the more solid matter of the earth, and that epoch when there could have been neither ocean nor atmosphere, they being but conditional substances, the subjects of that which must have preceded them, for neither will be considered as self-existing substances? All these perplexities and uncertainties that beset this inductive system of cosmographical research respecting the origin or the eternal duration of all things, do not put themselves in the way, or at all embarrass our deductive system of searching for the origin and relation of nature's multifarious phenomena. We have been able to demonstrate that for physical nature there could have been no retrospective eternity, but that all must have had relation to time, except the abstract elements of that very nature; and these we can not consider but as attributes of the great Eternal One; therefore eternity is applicable to them as respects their comparison to space and to time, but certainly not so with the physical phenomena of nature of which they are the originators.

We think we have made good the fact first stated, and from which all else follows, that the primary and eternal principles of all things in nature are in reality nothing more than an atom infinitely multiplied, having energy discriminatively attached thereto. However much this simple proposition may confound the philosophic world, these are nevertheless the only means by which Jehovah has measured out a universe in every phase of its complicated phenomena of mass or motion.

We will now assume that it will be no longer questioned but that these simple principles as primarily directed by Infinite forethought have been in themselves all sufficient for the progressive and final production of a universe. By strictly adhering to these fundamental truths of physics, and following the inevitable effect of this energetic attachment through its consequent processes, we have, in the most incontrovertible manner, so far as we have gone, either made good the solution of every physical problem, or settled the formula by which they can be effectually worked out.

We have found these radicles so ruling the vast progression of physical being, that the facts of deduction and the facts of observation are always equal, and each always in perfect confirmation of the other; even so much so that we are enabled to tell what there must necessarily be in nature, without previous observation of the fact. In pursuance of this deductive system, physical nature, in many of her most important phenomena became to us established facts before we were aware of their being those of observation, and it was only necessary to search scientific works simply to know if our facts of deduction had yet become facts of observation, and we have had the satisfaction of finding our inferences confirmed in every instance to which observation has extended. This coincidence was certainly well calculated to establish confidence in the scheme that so evidently conducts nature to finality in her formative processes, and likewise thus leads us on through every phase of phenomenal development to where we now find ourselves, and that is among the rocks of early ages, on which the first forms of earth's animated creatures have recorded their characteristic impress.

Now we have hitherto found this system of nature truthful and efficient in its teachings, and so we must still believe it when it tells us that organisms could not long have preceded this point in the earth's formative process. The conditions of matter requisite for the formation of crystals would be but ill qualified for the construction of organic forms, or that which contributes to their sustenance.

We have shown the final construction of atmosphere and ocean to have been of a later date than the formation of the granitic rocks and some other of the strata; and these rocks could not have very long preceded the first unquestionable traces of the paleozoic protoplasts, or first buddings of animated nature. Even if they had been formed before, they could not have subsisted without the changed condition of matter as it manifests itself in these substances; therefore geology has been truthful in making fossil record of the first generations of animated organisms that left their remains in the original mud of her rocks. This, too, must have been a time when the waters were tranquil, from the uniformity of temperature over all the earth's surface, and thus the sedimentary matter was susceptible of receiving the most plastic impress of floral or fawnal forms, let them have been ever so delicate, and of preserving them through all after ages. As nature never gets in advance of herself, it is certain that the radiata, mollusca, and articulata of this period were to it the best adapted and the most suitably conditioned for self-preservation. They were found at the bottom of the primitive seas, among deposits of soft mud, made by showers of impalpable particles so frequently falling at this period over those districts abounding in these rocks, and these particles passing through the newly-formed air and ocean in their descent, would be so much modified as to enable these creatures to keep themselves on the surface, except at epochs of great inundation, when they would necessarily be overwhelmed, as we find to be the case by the multitude of their remains in certain sections of these rocks, where generations of them must have succeeded each other, and seem to have suddenly ceased; admitting often great depths of deposit to have taken place without being further disturbed by their death struggle, or indented by their impress.

Total extinction could not have taken place (while times continued favorable for these forms) during these sudden casualties that covered up so many of them, because at the outskirts of the deposits the numbers preserved would have been equal to their reproduction and continued propagation through succeeding times of tranquillity, so that in the intermediate intervals of the falling matter generations of them would again swarm in the primitive seas, subject to a like fate with their predecessors. The very materialisms or conditional forms among which only they could live, would thus, at times, be the means of their destruction, by occasionally overwhelming them in its depths.

An approximate idea of the quantity of matter received by partial or sectional areas of the earth at these several accessions may be attained by referring to the depths of the rocks destitute of all fossil remains ; if these do not indicate each several accession, they at least show times when they succeeded each other so rapidly as to allow no time for these animated forms to propagate their species and people the seas.

This silurian system, and its equivalent accumulations of rock in various sectional areas of the earth's surface, is found to have become more and more prolific of organized forms as matter changed its condition, and as its rocks succeeded each other in superposition. Equal circumstances and conditions of matter would beget like character in the organic form, there being at this time no differences of climate to which organisms would have to accommodate themselves. The same kinds of organic forms we now have could not have existed in the seas or regions where matter for these paleozoic rocks was deposited, for to such they would have no suitable adaptations; these positions and circumstances would have been unfavorable for their formation or existence.

In thus pursuing the history of progressive nature by her own chronicling, we shall not find it difficult to perceive why these deposits were so partial. We have already remarked, that from the earth's perpetual change of position, because of her annual and diurnal motions, there could be no certainty where descending substances would impinge upon her surface, still the building up of this surface so unevenly is no more the result of chance than is any other subject we have yet considered ; the intelligent application of energy to matter is equally responsible for all.

When the fluidity of the earth's accessions had become so impaired that she could no longer retain her figure of perfect sphericity, the most prominent parts would possess the greatest attraction, so that descending substances would to some certain extent be attracted to them more than to other areas, and still in proportion to their increasing bulk would their effect be felt on other falling matter. It would not necessarily follow from this that the newer rocks must be superimposed upon those next preceding, because this partial influence, though felt in giving form to the earth, is in itself too inconsiderable to found a system on, at least without very many exceptions.

These situations of greatest attractive energy, though not immediately obstructing every falling body and appropriating it to themselves, would, nevertheless, in some certain degree, arrest and determine the position of fall; and should that even have been in the most prominent parts, the falling mass would so agitate the waters that most, if not all of it, would be washed down the sides of the acclivity; for such matter in its descent would be very susceptible of suspension in, and transportation by, the waters which were thus moved from their positions by these fillings up of the sea; but this would not be all, for these deposits, being but the nucleus portions of the falling mass) would necessarily leave suspended in the atmosphere all their extensive envelopes, much of which would there be condensed as it descended into vast deluges of water, and these would cause oceanic currents of some magnitude, tending still further to transport this soft sedimentary matter to the flanks of the marine mountains, or to the acclivities of the most prominent parts of the sea's bottom. The ocean by this time must have covered, so far as we know at least, all parts of the earth where the deposits of this period were placed; of this we have evidence, from the monuments of the time being exclusively marine.

Thus originated, by repeated accessions to the earth, all that immense mass of matter many thousand yards in depth which compose what are called the primary and transition strata; thus, too, originated by such repetitions of differently conditioned matter both our atmosphere and ocean, the latter having had great effect in the disposition of those strata. Thus likewise originated the earth's compressive envelope, the most essential and potential agent in giving solidity to these very rocks, and enabling their constituent affinities to effect in these massive and heterogeneous deposits such molecular separations, assimilations, and metamorphic transformations as should construct beds, veins, dikes, or dissimilarly involved masses, such as now characterize the rocks of these early periods. The whole depth of these deposits, when taken together as a mass of promiscuously mixed ingredients, whether having fell together, or at sundry times and between long intervals, would undergo in process of time all the affinitive transformations of affinitive adaptation admissible in matter under such circumstances. When they could no longer form crystals, they would assimilate into a semi-crystallization of lamellated layers in parallel planes, subdivisible into the various orders of slates and flagstones, the center of the several parallelisms or lamellated layers being the primary nucleus parallelisms of energetic action to which the particles were affinitively attracted, leaving the intermediate planes more susceptible of separation, because of their being the receptacles of the least assimilating particles.

This we have found to be the veritable history recorded by nature herself of all her early formations; we find so faithful a chronicling from cause to effect, that we perceive no single instance wherein they could have been separable or insufficient, and each is found to follow the other as inevitable facts in the great physical series of formative progression.

It certainly accounts with the greatest consistency for the origin and formation of the foundation granite, and for the limes, clays, and sands of the subsequent epoch, and for their alternating positions and admixtures with crystals and crystalline rock, etc. It shows, too, why there are joints and cleavage planes unconformable with the planes of strata; why these early strata are of such fine texture and fissile lamination (without attributing it to the tranquillity of the waters and slow comminution of existing rocks or quiet deposit of their detritus, with subsequent elevation of temperature), as is the usual idea; why the planes of stratification are often in flexual curvature and conformable with each other, while their internal structure of stratified lamina are at times in every form of contortion; why, intermediate of the strata, supposed to have been of aqueous origin, we find so many of the rocks imputed to igneous fusion—all these things are too distinctly traceable to admit a doubt in the unprejudiced mind.

Chapter Thirteen.

Aqueous Agency essential to the Formation of Rocks—Organic Formation—Conglomerates—Sands—All Substances Compounds—Coral Rocks—Subsidence of the Ocean—Coal Beds—Transformation of Water.

So far as we have yet perused the physical volume, we find no record of igneous action as the cause, origin, or metamorphic condition of primary strata and intruded beds of crystalline rock, or any necessity that there should have been.

But with aqueous agency the case is altogether different. We have the whole history of its origin, and the evidences of its first action transcribed in characters not to be mistaken.

We deduce water as having been a necessary consequent of affinitive and compressive conditions at a certain epoch of our earth's progression, and we find the geological period when the efficacy of this formation is first made manifest, and before which there is not the least intimation of its having been a property of the progressing earth at all. We find record of the covering up of almost the whole earth with this fluid about the close of the silurian deposits; but its agency could not have been required for the production of the materials for either the rocks or their transition passages into each other. or the granite into which they often imperceptibly pass.

There could have been through the vast epochs of these deposits and formations but little grinding down of old rocks for the formation of new ones; for before the formation of water they could not have consolidated into rock at all; neither could they have been ground down by its means. And even if consolidation could have been caused by the mechanical pressure of other superimposed rocks, which is so often assumed, that pressure alone would have preserved them from the eroding process by water or otherwise.

Water was unquestionably highly essential to the consolidation of rocks, and even with its perfect saturation the process of affinitive assimilation and consolidation must have been an operation involving an almost infinity of time. Water being one of the essential means for stratified formations, it certainly would follow that it must have been formed in some quantities at the time matter first assumed that form. We can not even conceive how crystallization, even in the granite, could have taken place without its presence.

The matter from which the granitic crystals were formed may have been long deposited, independent of its saturation or action, but they could not have crystallized into solidity in its absence, neither could the matter have contained it when precipitated upon the earth, or it would not have been piled up so unevenly; water, being a general leveler of light matter, must have spread it more uniformly out; water, being a compound, and constructed of insensible substances, must have depended on secondary circumstances for condensation, and these circumstances too far on in the grand scale of progression for it to have been plentiful when the granitic matter was deposited. One of its constituents is the least ponderable of known substances, and would not unite with its associate in a concentrated form by their own mutual affinities unless forced by vast pressure of impact, which pressure, we have before shown, could not have been sufficient to have effected this formation till that epoch, which gives unmistakable evidence of the effects of water in the formation of its rocks.

But though the crystallization of the granite could only have taken place in the presence of water, and by the appropriation of its constituents in their construction, this is no proof that water prevailed during the deposit of the granitic materials for the matter of granite could have been subsequently saturated and crystallized by aqueous efficiency long after that substance had been deposited.

While thus geologically enabled to determine the commencement of the aqueous epoch, we may not have equally precise proofs of the incipient production of our sensible atmosphere. That, too, being a compound, must be of secondary creation, and therefore had its epoch of origin; but being more susceptible of mingling with other gaseous matter, its approach to its present state would be more progressive and less definite in its introduction than water. But though we do not know the precise period of atmospheric formation, we do know that at the most early dawning of the protozoic period the earth had formed to herself such an atmosphere as was sufficient for the first germs of vitality, or she could not have generated these primary protoplasts, or first dawnings of an organic creation. This may be regarded as the epoch of formation for our present atmosphere, at least it is the beginning of a new order of things that could not have existed without an atmosphere; and as nature is never in advance of herself, we can not perceive why it should have existed when there were no objects requiring its presence.

Having now followed the progressive formation of the earth upward from her most fundamental molecules, through all her aggregative and formative phases, involving cycles of untold centuries of time, and much important phenomena, we now find ourselves contemplating a geological epoch in which new and increasing varieties are introduced. Among the most important of these are the atmosphere and ocean, particularly when considered in connection with the vast races of organic and sentient beings destined to inhabit both, and whose prototypes we now find beginning to unfold themselves, thus indicating a purpose in all that has preceded them. Not only do we now find the construction of a world-wide stage on which the future operations of nature were to be enacted, but we likewise find the construction of substances in which organic operators could be originated, sustained, and supplied with all requisites for enabling them respectively to perform the part assigned them in the great physical drama of existence.

This ocean and atmosphere must have had much influence in molding the form of this mighty stage; but they are by no means to be considered as permanent and immutable productions, continuing through all ages the same in quantity; but, on the contrary, they are to be regarded as great reservoirs of readily transferable and convertible matter, accumulated by nature for her prospective paleontological systems, of which we now begin to find the prototypes in this paleozoic strata.

Evidences of the convertibility of water into gaseous vapor, and the transformation and concentration of aqueous and gaseous substances into concrete forms of organic and inorganic characters are so constantly before all eyes, that they can not have escaped the notice of the most careless observer. There are no compensatory equivalents in these substances themselves by which this constant appropriation of their matter could have been made good, therefore there must have been a constant diminution proportional to the quantity appropriated for the purposes of physical progress, and (unless supplied from some other quarter) the atmosphere would soon have been exhausted of its most essential ingredients.

The ocean, therefore, may be considered the grand reservoir of replenishment. We need not urge so evident a connection of transfer as nature has thus established between these two world-encircling substances that are so readily associable. The atmosphere would be unable, even in our day, to supply sufficiently the continual demand made upon it, particularly when vegetation is vigorous. We do not suppose the reciprocating action of the atmospheric fluids, and the solids into which they are converted, are so perfectly balanced as to leave the quantity of atmosphere always the same, whatever may have been the demand upon its matter in the construction of other forms; its transmutation into other substances may not be freely admitted, but one thing is very evident, and that is, that organisms or other things are never constructed when it is not present in some of its proportions. Artificial chemistry may not readily convert aqueous components into atmospheric properties; but nature is not limited within such narrow bounds as those that terminate man's abilities. The molecular affinities have formed the recognizable elements of artificial chemistry under conditional circumstances, and by conditional circumstances they may be reconvertible into other forms, for none of these supposed simples can be composed of ultimate molecules, or they would not have been recognized at all; for our senses are not ethereal enough to comprehend so clearly the real essence of things, as to be able to appreciate forms in their first remove from their Maker.

Therefore sensible substances of every sort are subject to transmutation, by metamorphosis of the molecular action which constructed their kinds.

All the forms or conditions of chemical elements are as much secondary in their characters and creatures of circumstances as are the most sensible substances we see; and though art is unable to reduce them further, the chemical affinities themselves are constantly producing transmutations of character.

However much repudiated by the existing systems of science, or by physicists in general, this transmutative subject may be, no order of physical research can be sound or successful that denies to nature the convertibility of the constituents of any substance in nature.

We can not expect physical science to fathom the subtilties of nature in its secret workings, when we must be aware that every phenomenal expression, whether of force or fabric, if recognizable by the senses, must be the effect of forces and forms infinitely multiplied. Our senses can comprehend a crystal when we find it occupying sufficient space and certain geometrical figure, but they can not recognize individually the radicles or forms that have erected that crystal. We can comprehend organic forms when fabricated in their grossest grades, but we can not possibly have the least recognition of the molecular constituents whose affinitive combinations make up the sensible portions of such substances. And when it is considered that there are myriads of animated beings in the full development of their organisms, that are but barely recognizable by our senses, even when assisted by the very strongest magnifying powers, while these, in all their parts, must be made up of an infinity of molecular constituents, hence it must be evident that either our organs of sense, or any means at their service, must be very inadequate instruments by which to determine of sensible substances being no longer divisible into severalities. The very idea of substance or form is so significant of fabrication, that we can not conceive why it should be for a moment assumed that the substantive constituents of either our atmosphere or ocean are themselves simple existences, when such could only have been the beginning of all beginnings, the unit of all physical numbers, the mathematical germ, the indivisible point, the last, the least omnipresent atom or root of every calculable thing. How, therefore, would it be consistent to suppose that substances usually assumed to be elementary, although so far in advance as to have acquired sensible condition, are intransmutable by nature, when it is so evident that they must have been fabricated by an infinity of action in the initial numbers?

We find nature constantly effecting the transmutation of substances in which art has been unable to effect the change, therefore when we thus find every form or condition of matter that is readily recognized by the senses thus subject to mutation, what should justify the conclusion that they are immutable, where art can no longer accomplish their reduction? Why should we assume the measures of nature thus restricted to the limited modes or resources of art? We have certainly no right to assume that our finite senses and tests are any limit to the sphere of nature's infinite operations.

While no one is able to enlighten us with respect to the ultimate and immutable elements of which their own organs of sense are constructed, how can we be informed with respect to the fundamental integrants of less sensible things. These very organs on which so much dependence is placed, as well as all other observable conditions of matter, are only to be regarded as the sensible sign of a vast series of formative progression having preceded such development of substance and evolved such sensible forms.

Now from all this it will be seen that we infer a possible transmutability to all the sixty odd substances that are now assumed to be simple elements; we can only regard them as evidence of man's analytical abilities having failed him in pursuing the reductive process further; but that, at the same time, nature freely avails herself of the mutability of all such substances in their convertibility into new forms and conditions. She recognizes no immutability but in the rudimental atoms of all. There may be many substances that are not readily susceptible of change under ordinary circumstances, but that is no evidence of their perpetual immunity from all change under any circumstances. Who will say, for instance, and by what hypothesis will they undertake to fortify the assertion, that the constituents of water (a substance whose presence seems so essential in the formation of most all substances) are not convertible as constituents of many solidifying substances; and that water itself, from its first flowing into the depressions of the earth until now, may not always have been in fluctuating quantity, regulated by the circumstances of its formative product and appropriation?

We have seen the means by which the waters of the mighty ocean were formed; they were of such character for accumulation as must have overwhelmed the earth forever with their floods had there been no transmutations of this water into the massive formations of the earth's rocks.

Chemical analysis can recover from solid rock of some kinds what is called their water of crystallization; but that may be regarded as a small matter, only in so far as it is an evidence that the sensible components of water were convertible together, that is, in their compound character, and without decomposition; and when liberated they were ready to resume their fluid character, and be again water as before; but such does not say that water was not decomposed, and its constituents severally appropriated by the consolidating rocks. We may certainly and safely consider that in the whole consolidation of our earth's rocks, even down to her very center, there must have been an immensity of the component ingredients of water appropriated either in associate or disassociate form, for it is impossible to imagine the consolidation of the particles of matter, either in crystals or by compression, without the instrumentality of this aqueous agency in some of its conditions. We now see no process of nature in which the agency of this substance does not seem highly essential.

Even at this day we see none of the activities of nature without its presence, unless it be in the drifting of sand and dust; and even in this particular the driving medium has for one of its constituent ingredients a component of water, and this component is not only common to both water and atmosphere, but it is seen to be largely associated with the substances of the earth's rocks.

The waters of the ocean being furnished and largely augmented by every accession of cometic matter received from such bodies as furnished their energetic nucleus substances for the formation of the earth's strata, would have kept her more solid matter continually submerged in increasing depths beneath the ocean's surface, and in proportion to the quantity of solid matter deposited upon the floor of the ocean would the waters raise their general surface-level, so that had water, when once formed, been a constant quantity, the land could never have appeared above this water-level, unless the whole solid matter received had been placed upon or piled up in one position; which we have seen could not have been the case, for although not uniform, each district was subject to receive its share. Now when we consider the susceptibility of the aqueous substance to associate with almost all other substances, we can perceive by what process its quantity would have been reduced during those epochs when no accessions were made to the earth's mass. We will now, therefore, proceed under the implied certainty that the quantity of water in the ocean has been subject to great fluctuations while meteoric substances were descending at long intervals to make up the earth's quantity, both in water and stratified rocks, and while these rocks, or their raw material, were requiring aqueous accessions for the furtherance of their solidity.

At that period which terminated the silurian series of formations, it is found that geological conditions have very much changed from those characterizing the inferior members of that group of rocks. This indicates that a series of ages must have elapsed during the formation of this great system, not only because of the depths of these deposits received at such uncertain intervals, but because of the characteristic qualities of the rocks immediately succeeding or superimposed upon each other, which time must have enabled it to acquire by its own affinitive action when forming the molecules of bodies while isolated in space, and before being received by our earth; this, aided by circumstances attending its descent and deposit, through the earth's augmenting atmosphere and ocean, determines it to be of lithological character, different from that which preceded. For, as we have often said, we say again, it is a preposterous absurdity, to suppose the masses of matter, constituting the rocks succeeding each other in geological progression, has been derived from the disintegration of those previously existing. There is not in nature, nor ever could have been, such complexity of mechanical action as could have produced the stratified groupings and passages of lithological transformation as geologists find characterizing their several great systems of deposit.

From whence, for instance, agreeable to this great mechanical theory of formation, could have been derived the vast accumulation of materials composing the old red sandstone and mountain limestone? Even if there were any indications of pre-existing rocks, whose destruction could have furnished the matter in such quantity as would have been required for these rocks, it is impossible to conceive circumstances equal to their development in the places where we find them, or that could have caused their conditional characteristics.

These rocks, and their equivalent representatives in other regions, are altogether inexplicable except in the order in which nature produced them by the progression of the earth's mass, as consequent from the concentrating tendency of all matter situated within the attractive sphere of our solar system, and subject to be intercepted by its members on its downward passage. We have seen how these contributions to the earth would change their molecular character progressively in the process of time, as they themselves enlarged, and before they become a part of the earth's mass. Now this affinitive action, effective on the matter of these bodies, would certainly continue and accommodate the contributed matter to the circumstances to which it would be subjected in making a part of the earth's aggregate quantity, and these aggregate affinities of the earth's matter would necessarily metamorphose it into those formative conditions by which it is now characterized.

The consequences of this new order of affinitive action, or, rather, the conditions to which affinity is subject, we find in the assimilated sorts of constituent matter composing the several members of the great geological systems, be they in mass interstratified, or transverse in the form of veins or dykes.

This process of formation comprehending only the great geological systems, must have occupied an inconceivable length of time; but so long as matter has energy that can not cease its action, it will not rest, at least so long as the molecular affections have any chance of farther satisfaction; and if they have been effective at all, of which there can not be a question, it is certainly to the extent we find demonstrated by geological structure as it now exists, for that is but a continuation of the aggregating process effected by the affinity of matter. Affinitive action, or the gravitating effect of matter, must have caused the compilation of the mass of mixed ingredients from which rocks in all their variety were made, and the matter of their substances must have undergone some degree of modification or change while in the waters on their descent to the bottom, communicating thereto a tendency to stratification, by beginning the assimilating process while in suspension, which the continued action of their own native affinities (operating through all subsequent time) has further perfected in the present order. It will be evident that as the earth approached the finality of her aggregating process, contributions would become less frequent; so that by the time the old red sandstone and mountain limestone deposits were contributed, the intervals must have been very considerably protracted, leaving the waters on the face of the earth in long periods of tranquillity, and thus giving to encrinital and other inhabitants of the ocean peculiar to this period an opportunity of propagating their species through myriads of generations. We find still further evidence of the length of these periods in the dissimilarity of these rocks to preceding ones. We perceive that matter by the incessant activity of its own affinities would, in process of time, become so metamorphosed in the contributing bodies, before they reached the earth, as to be disqualified for the crystalline structure distinguishing the more primary rocks. We therefore first find the crystallization becoming more and more imperfect or confused, then discontinued or passing into limestone or clay, then into sand, and the sand into conglomerate and breccian rocks, and, as we should expect, all by slow and almost imperceptible gradation, only where the progression is rendered incomplete by the absence of more or less of what should be intermediate beds.

If we consider the subject aright we can not for one moment indulge the idea that all the argillaceous particles are so many parts of broken-down crystals, or that the vast masses of arenaceous particles are the accumulations of previously existing rocks. Even admitting this disintegration to the fullest extent, by what process, we would ask, could these sands have been sifted and separated agreeable to their grades, as they are now found? What circumstances could have effected such comminutions, such separations, such transpositions, and transportations of these several kinds, having all the same origin? And again we ask, where were the sources of all this matter situated? or from what direction brought? Fragmentary materials would most unquestionably be distributed to some extent among these accumulating masses in the middle period of geological progress; but the idea of their being altogether of a fragmentary character is not worthy of being for a moment entertained. We even conceive strong doubts of the fragmentary character of all the coarse sands, conglomerates, millstone grits, and breccias, though these bear stronger evidences of being parts of preceding formations. Even these, as a general rule, are no more derived from other rocks than are rocks of the finest texture. The constituent forms of these conglomerates and breccian beds were as much composed by the affinity of approximate particles, causing them to concentrate into the concrete kinds that form these rocks of various kinds, characters, and colors. There can be no question but fragmentary parts of former deposits have been more or less involved among primary matter, which would in all probability induce its affinities to adapt that mode of structure for the whole bed in place of the usual stratification, all conditions of rock being those which the constituent affinities could most readily effect under the circumstances and conditions of the deposited matter.

We have no right to consider the affinities, in their formative capacity, restricted to any given rule, while we are constantly encountering multiplied proofs that the ways of formation are infinite; and though the texture of rocks may in some degree indicate the primary condition of their matter, still we are not to suppose it came down in limes, clays, or conglomerates; but we do know it must have been, when deposited, in the most suitable condition for acquiring its present characteristics, or it could not have thus attained them.

If we can conceive of the molecules of matter forming themselves into grains of sand, and cementing themselves together into a solid rock (which we know has been the case), we are far on the way of finding how the seemingly fragmentary constituents of conglomerate rocks have been constructed; and we may almost go so far as to say how all other kinds of involved masses were originated in their concrete forms. Most of the conglomerate and breccian rocks are so well cemented as to indicate an order of affinitive formation, more than a simple cementing of detached fragmentary forms; and even the slight cohesion we sometimes find is not any proof of fragmentary origin; for that is easily accounted for by the primary intermixture of incongruous matter, afterward purged out by each concrete component in their several affinitive formations, thus leaving intermediate, unadhesive, and unassimilating matter that could unite with neither. It is often observed by geòlogists that the most prevalent forms in the composition of conglomerates are traceable to contiguous rocks of the same structural type, and of which they are considered to have been parts, and more particularly because of their occasional passage into such rock. But this simply indicates the tendency of the matter in such vicinity to assume a severality of structural character, finally yielding itself in favor of some more convenient form into which it passes, and hence the progressive passage of one form of rock into another.

Would geologists but watch the passages of such rocks, they would perceive them to be but a transformation of the affinitive ways of formative ingredients, instead of being the progressive passage of homogeneous rocks into heterogeneous mixtures of their own fragments with other forms carried out in the same continuous planes. It is easy enough to conceive of gravel and other ingredients being spread out in a comparative plane by the action of water, but it is impossible to conceive of the passage of conglomerates (whose fragmentary constituents are of every form and size) into quartz or other rocks having perfect homogeneity of character. How, for instance, could these parent rocks have been broken up, and their fragmentary parts rounded by any action, without removing them farther off from their source? It is said the conglomerates have acquired their rounded forms by attrition among the waters; but this could not take place, and they still retain such proximity to the parent rock from which they are supposed to have been riven, as to run imperceptibly into such rock, or to pass off progressively in the same plane of strata until they become lost in formations of decidedly different character and construction.

All rocks of the same geological age have this very decided tendency to pass into each other, a circumstance as little to be accounted for by the usual hypothesis of formation as is the passage of the conglomerates themselves. This tendency only proves that matter by its affinities was in that condition all but ready under certain circumstances to assume almost any one of these conditions; it may be crystallization, or stratification, or rounded, or angular concrete substances agglutinated in beds by a common cementing matrix, including unassimilating sorts, or such as was rejected by the concrete forms. Even if we could see by the usual theory how conglomerate and other rocks have become mixed up and made to pass into each other, we are still at a loss in the breccian order of beds. By what combination of circumstances could the parent rocks have been fractured into these forms, and the forms separated, and then placed, with their angularities preserved, in the positions they now occupy, and fitting so favorably as they are found to do? They, too, pass into other forms of rock, and are so large, and small, and specially fitted in their constituent forms to each other and to the common mass they construct, as could have been the effect of no chance mixtures or fortuitous effect of forces acting upon these ingredients. We are under the necessity of speaking of kinds of matter as making up the geological formations and material conditions, and as these formations advance in the ascending order, the kinds entering into their composition seem to multiply; but we must distinctly understand and bear in mind that matter in the abstract could be of but one kind, and no subsequent circumstances, forms, or combinations imposed could have changed its intrinsic nature. It could only have become differently conditioned in its molecular characteristics by the grade of its affinities as primarily imposed. Nor could this affinitive gradation have consisted of kinds or complexity of characteristics, these gradations being simply in degree, a graduated unit representing different degrees of the same identical force.

The different characteristics of matter, therefore, can not have been caused by variety of kinds in the ultimate principle itself, but are consequent from the forms of effectiveness which this graduated affinity would induce the ultimate atoms to take in molecular formation, and to the combinations of which these forms are susceptible under the circumstances to which they are exposed. From these combinations, and their circumstantial susceptibilities for change, we have all forms, all conditions, all color, all life, all activity, in a word, all nature's sole embodiment.

All the kinds of chemical matter now supposed to be simples are not in reality so, but only undecomposable under those chemical or mechanical circumstances or tests which have yet been applied by art.

If there were removed from these assumed elementary substances, or any other sensible form of matter, the pressure to which they are constantly subject, their more effective forms constituent of such substances would instantly expand into utter invisibility by surrounding themselves with forms still more lightly affected.

How, then, could artificial chemistry find the different kinds of matter in substances that had thus become ethereal essence far beyond its analyzing powers or processes.

No one will be so bold as to say a thing is annihilated because it is no longer within reach of our senses; in reality it is only in these regions remote from the senses, in what we may call matter's etherealization, that nature elaborates the forms of matter she is about to manifest to the mind through the medium of sense. These first forms of sensible substances acquire their matter and mechanisms by measures unknown to chemists. The smallest forms exposed to view by the most perfect instruments of power are often found to be organized beings; what, therefore, can art be expected to do toward analyzing the molecular forms of which their circulating fluids are fabricated?

Every substance recognized by the senses, or made subject to any species of chemical ordeal, must necessarily be far advanced in the scale of formative progression, notwithstanding the inability of art to accomplish their reduction, for between finite recognition and metaphysical abstraction there must be a wide interval through which material forms must have been made to pass.

All sensible matter has its origin in circumstances and conditions, and with them is subject to change its formative state. At the commencement of the carboniferous era, therefore, conditional circumstances were such, that instead of the granitic ingredients of the more primary periods, there were the limes, sands, clays, and conglomerates of the middle passage. In place of the ethereal gases which constituted all other forms of unsolidified matter in granitic times, there were, at this time, the atmosphere and ocean, as well as many other combinations and conditions, which now constituted part of the rocks, and has seemed to be simple elementary properties until their decomposition was effected.

All sensible substances being molecular compounds, and in themselves decomposable, and the converting of decomposable substances being alone the high privilege of nature, she has been enabled by its means to give such expression to her progress as geologists now recognize in the rocks. She has instituted the ocean as the most ready reservoir of convertible matter by which such formations were effected in the forms of structure that now distinguish them.

This aqueous substance must have been largely appropriated and applied in geological formations during primitive times, as we have before stated; and during long intervals between accessions to earth and ocean it is evident that this constant appropriation of the sea water (by the masses of deposited matters) would cause the surface-level of the ocean to subside, and exposed portions of the earth thereby become productive of terrestrial vegetation; but it is likewise evident that those portions first appearing above the sea would necessarily, as a consequence of their greater prominence and exposure to the effective action of the elements, subsequently be denuded of all vestiges of such vegetation, together with the soil from which it sprung. Therefore it is only in the deposits of what were then plains or depressions that we need expect to find the record or relics of the vegetation of that period. And we further find that even these could not have been the first vegetable forms presented by the prolific earth; for those portions of land that emerged first from the ocean would necessarily be the first paradise of plants, the originating grounds for the primary forms of earth's flora.

But we find the first forms of terrestrial flora, not in the most prominent or elevated portions of the earth, but among the mass of deposited matter spread out in plains and in depressions, and we infer that the relics of these prototypes were lost in the action which caused the denudations of the grounds on which they grew.

These alternating periods of appropriation and production of the waters of the ocean would necessarily cause such oscillations of the sea-level as would produce alternate submergence and reappearance of certain portions of land through variable intervals of time. We have no means of measuring the length of these alternating intervals, but we may safely infer that between each one of them there may have been a period of longer duration than mankind generally allow for the whole age of the world. This, however, will be no criterion by which to count on the earth's accessions, only in so far as when they together were sufficient sensibly to elevate the ocean's surface. Many intermediate minor contributions may have been made from time to time, but not sufficient to produce any sensible result on a general scale.

Large indeed must have been the contributing bodies (or very many of them about the same time) that could have elevated the ocean's surface by accession of aqueous matter and formation of water, or filling up of the sea bottom by the more solid deposits of descending bodies.

But that there were such times and circumstances of contribution and exhaustion or appropriation of the ocean's waters we have the most ample testimony, not only in the necessary order of nature as deducible, but in the formations themselves that are found alternately of fresh and salt water origin. These facts themselves seem to us very conclusive proofs of the oscillation of the ocean surface. In the mountain limestone formation we find monuments of their marine origin, and in them we have the record of their emergence from underneath the seas in which they were deposited, for we find in them relics of organic forms that could not have flourished except in comparatively shallow water. This group of rocks, and even all those inferior to them in position, are often found elevated far above the level of the carboniferous or coal formations, and yet they are (so far as found) altogether marine deposits. Still their being marine deposits, and now so far above the level of the ocean, is by no means proof that they have been upheaved from the depths of the seas in which they were placed. We have plentifully proved that they were piled up as the contributed products of external bodies, and not heaved up from internal sources by powers altogether inconceivable in character.

The action of water, and other eroding influences, have operated upon these elevations from the time they were formed until now, divesting them of every vestige of vegetable relic, but without accomplishing their own entire reduction; and had it not been for these erosions they would unquestionably have been much higher than they now are, and they being of marine origin show that the seas have receded very much faster than they were reduced by the process of denudation, to which they have been exposed.

This subsidence of the general ocean would in primary times be a process of considerable rapidity; for when large masses of deposits, even including all previous rocks, were in process of structural formation, they would in virtue of their molecular affinities, aided by the presence and convertibility of water, concentrate and condense into their own composition vast portions of this substance; and if we need further proof of the convertibility of water into rock, we find it in the coralline rocks that are now, and have been in all ages, forming in the midst of the ocean, by the secretions of carbonate of lime from the organs of polyparian tribes of animals that have at all times inhabited the ocean and accumulated vast quantities of this matter. As they can not create they must necessarily manufacture this rock from materials within their reach, and there was nor is any other source but the sea water, and no system of transportation by which such matter could have been brought within reach of their secreting organs, for their conditions are such that they could not go in quest of it themselves.

We consider the attempt to account for the production of so much matter by the transporting agency of thermal springs—bringing it up from the depths of the earth, and disseminating it over half the globe—as both futile and unphilosophic. All experience most conclusively proves that limestone, or carbonate of lime in any form, did not even exist before the introduction of water, nor even until it had impressed upon rocks stratified evidences of its presence and plentiful effect.

We consider there would be as much sense in attributing oyster beds to the action of thermal springs, for oysters, as well as all other of the molluscan tribes, must procure this matter in the several localities where they are situated, without reference to any such springs.

It could not have existed as an independent property or in solution in the ocean, or what by this time would have become of the poor creatures whose progenitors must have exhausted the whole stock of matter from which their frameworks are to be constructed? We see no evidence of failure in the article as yet, even after all the vast quantities that have been accumulated.

So the only alternative is to admit that organic forms have the faculty of assimilating substances that seem to us simple properties, of which we have constant examples in the secreting organs of animals and plants; the transformation of the food for our own sustenance is no inconsiderable one, particularly in the convertibility of all sorts to chyle, and the constant evolution of the carbonic acid gas from our bodies.

Seeing therefore that nature can in one way accomplish the entire transformation of any of her materials, we are bound to admit that they must be obedient to her will in the whole framework of physics. And it would certainly be absurd to suppose that she had fixed so much of her matter as to make it no longer appropriable. We have constant opportunities of observing how essential water is to the multifarious operations of nature, and we can not for a moment suppose that its simple presence, without any transmutative change, is all that is needful in the formations so constantly requiring its aid. The materials of this substance therefore may be assumed to have associated extensively in the constructive character of geological formations; for if essential in any sort of formation, we may infer its requisition in the structure of rocks, they being all unquestionably of a formative character, even those that seem to be of most mechanical construction. The affections of matter are ever present and ever active, and will not permit it to remain for a moment in the same degree of dissolution in which casualty may have placed it. Therefore when the affinitive structure of any portion of primary matter had been destroyed, these forces could not have permitted it to remain in perpetual ruins; of this we have evidence in the structural formation of the earth's strata, for we do not find the matter indiscriminately mixed up as when first deposited, or in such heterogeneous confusion as such matter must have been in, were it the broken-down fragments of former rocks transported to their present place by the force of waters, as is so usually assumed.

If those engaged in scientific research could but give up the idea of "special kinds of matter," and that any of its ultimate conditions are appreciable by the senses, or are "unconvertible simple substances," they will have made a very important step in physical progress, one that will enable them to follow more freely the unrestricted rules of nature, who has brought matter by her own formative formulas from the depths of infinitude, where only it could have had an eternal fellowship with that Intelligence of whose scheme of physical creation it has become the realized expression.

There would, in such case of recognition, be some prospect of the realization of what we regard as one of the great truths of nature most conducive to the furtherance of physical inquiry, namely, that the molecular sphericles constituting atmosphere, ocean, and even the everlasting rocks themselves, as they are sometimes called, have no perpetuity in their present state; but that all known substances, whether assumed to be elements or not, are more or less subject to metamorphosis of their molecular structure when in association with other forms of matter, and that these metamorphosed conditions may leave no traces of their former identity. So far from having an immunity from such mutation, the atmosphere and ocean are the ready receptacles for, and reservoirs from, which formative nature furnishes most of the rudimental molecules for the erection of at least animal and vegetable structure, and no doubt as officiating largely in the formation of rocks.

Now the effect of this would be the diminution of the ocean on which the atmosphere so largely depends and draws for the replenishment of what it supplies toward the fabrication of physical organisms more and above what they return; and this must be of very extensive consideration, if we have to take into account the vast accumulations of carbonaceous matter concentrated in the rocks, and which is said to have floated in the atmosphere as carbonic acid gas before it was thus condensed, and besides as the extraction of this property from the atmosphere is still going on without any indication of exhaustion, it must have a compensatory supply from some convenient quarter.

We find philosophers telling us there must have been an exhaustion proportional to the quantity of carbon thus concentrated; for, say they, the atmosphere of early times, with a mixture of so much carbonic acid gas, was peculiarly qualified for the production of that prolific vegetation which they assume to have flourished so abundantly during the carbonaceous epoch, as to have caused by its own contributions the formation of coal beds, which we are now about to consider. All this certainly implies a diminution of this ingredient in our atmosphere, which would terminate in its total extinction were there no equivalent supply from some source.

How much soever philosophers in general may entertain this idea of carbon and vegetation to such an excess in early times, we at least do not; for, on the contrary, we think it very unphilosophical to entertain any such notion. We see no cause for its production in such quantity, nor how so ponderous a gas could have been suspended in the atmosphere, had it even existed as supposed. Why, with its greater specific gravity, it did not form a stratum of itself under the atmosphere to the total extinction of all organic life we can not conceive. And even suppose these questions could be satisfactorily answered, we would still ask, How could carbonic acid gas, even if it had existed, have caused such an immense amount of vegetation to the square foot, as is often found imbedded in the rocks. No circumstances could have made it possible for such quantities of vegetation to have grown on any surface as is usually assumed in theoretical geology.

Indeed, there is no rule by which it is at all possible to reconcile the origin of the coal measure with any of the theoretical views entertained by geologists; for the hypothetical inferences are all too extravagantly forced and far-fetched to be admitted as the measures by which nature originated this class of rocks. The prevalent supposition of some geologists is, that each separate series of coal beds in the several coal fields that are interspersed over the face of the earth were formed by vegetation growing on the surface, and accumulated in quantity sufficient to form the respective coal beds; and that when the vegetable growth for the first or inferior coal seam had accumulated the quantity sufficient for its formation, that the ground on which this accumulation grew then sunk down far below the level of the ocean or fresh-water sea, and there remained for a sufficiently lengthy period of time to receive, through the action of the incumbent waters, matter sufficient for the stratified formations that are superimposed upon and intermediate of these first-formed vegetable beds and those next succeeding or superior in place. And when these accumulations of intermediate matter had taken place, that by some upheaving process the whole coal field was again elevated above the ocean-level, and there made to remain a sufficient time to receive another growth of vegetation sufficiently extensive to form the next succeeding coal bed, when down the whole went again far beneath the surface of the ocean, as before, so as to receive matter for another series of supervening rocks, after which to be again upheaved above the level of the sea to receive another vegetable accumulation, and again to subside for its supply of superimposed rock; and so on alternately, every coal field being thus elevated and depressed during periods sufficient for the accumulation of the terrestrial vegetation required for the formation of their several seams of coal, and for the marine or fresh-water deposits which made up the intervening strata, and this process continued and repeated for each coal bed there is in each coal field, whether there be one or sixty-one in a series, or whether these coal beds be of the thickness of one inch, or thirty feet, which some of the coal beds are found to be; and that for each respective coal field on the face of the earth, there were separate and special orders of the upheaving and down-settling process applied. Now what is to be said for all this? *Such a scheme* for the acquisition of coal fields is certainly not only too much for credulity, but even for patience itself. Having to discuss the contemplation of any thing so preposterous seems as if it were a waste of time, it being so evidently of that character which it is absurd to attribute to nature, for she can never be reduced to such monstrous or miraculous expedients in the promotion of her purposes. Were we not well aware that such views are entertained by geological thinkers and teachers, it would be equally difficult to credit them, or treat them respectfully, and we would spare the questioning with respect to these upheaving forces, or what ruled their conduct in these revolutionary paroxysms, producing the effect by which these extensive areas of our earth were elevated and let down to and from the bottom of the ocean, in such series of successive alternations as these coal fields would signify, by the quantity of many of their coal seams. Neither would we have to inquire by what possibility such masses of vegetation could have grown or accumulated upon any portion of the earth's surface, even under the most favorable climatial conditions or other conducive circumstances as some of the coal beds would have required, to constitute their vast thickness.

However much every circumstance might favor the growth of vegetation, still but a comparatively limited quantity could have occupied the surface at a time, room being required even in its most prolific production; and at the same time, had the whole space from the ground as high as the top of our present forests been occupied with a solid mass of vegetable matter, it would not have furnished sufficient carbonaceous matter to have constituted many of the coal beds that are found in the earth. If this vegetable matter in its growing condition could not have furnished the quantity for any of the beds, neither could it have been accumulated in that which had fallen; for the circumstances that could have been conducive to its prolific growth would have been equally favorable for its decay, so that it could not have been preserved and accumulated in such quantity on the ground as to have contributed the material for many of these massive coal beds.

Now there are certainly insuperable difficulties in the way of the earth having acquired her coal measures after this fashion, and whatever the advocates of such a hypothesis may do to soften them down, they will continue as insuperable obstacles still. Thus we dispose of one of the only two ways by which theoretical geologists have undertaken to account for the earth's acquisition of her rocks as they are now found accumulated in her coal measures.

The other hypothetical system by which some geologists seek to account for the accumulation of such quantities of carbonaceous matter as now make up the coal beds, assumes extensive countries situated somewhere, and covered by a dense and luxurious vegetation, from which extensive rivers flowed into the ocean, or into lakes, gulfs, or bays of the seas to which they transported, at certain times, quantities of drift wood and other vegetable products, which they deposited in these bays and estuaries; and that this transportation and deposit of vegetable matter, after having continued for a time sufficient to have deposited that which was required for a coal bed, was succeeded by the transportation and accumulation of sand, mud, and other matter which form the rocks that are intermediate of these coal beds. This alternate transportation and deposition of vegetable products. and of the detrital matter of the ground on which they grew, is what is assumed to have furnished matter for the associate beds in the several coal fields; rivers being thus instrumental in furnishing the different kinds of material of which they are composed. This method of attempting to account for the formation of the coal measures is at times qualified by the consideration that extensive rafts of drift wood and other fragmentary products of these primeval forests, in being borne along by the rivers, may have accumulated in large quantities at the mouths of these rivers, which occasionally settled down on the bottom to form these coal beds. And as an illustration of this idea, the rafts which have been found formed on some of the tributaries and at the outlets of large rivers, as that of the Mississippi for instance, have been cited as examples.

Now between these two systems there certainly is not much to choose. The one calls for the carbonaceous and other stratified matter of coal fields by the upheavals and down-settlings of the whole foundation-area of each coal measure, and the intervention of required periods of sufficient length, involving the necessary circumstances for the production of the different kinds of deposit contained in these coal basins. The other requires, not these convulsive forces of upheaval, but that rivers must have been instrumental in collecting from some quarter and accumulating vast quantities of vegetable remains in certain localities, and of depositing them in lakes or deep seas in sufficient quantities for the several coal beds; and that when this was done, they ceased their transportation of vegetable matter and employed themselves in procuring and transporting the sand, mud, and other materials with which to cover the carbonaceous or coal-forming matter up, and when thus prepared for another bed of vegetable products to be again superimposed, from which to form another coal seam, these imaginary and convenient rivérs alternated their effective conduct in collecting and transporting the several kinds of material, until the respective coal fields were formed. But what then became of these rivers, or the countries from which they procured their supplies of vegetable and other matter for such an operation as this, the advocates of this transporting system do not seem to say; but they must have been very effective while they did exist, judging from the many and extensive coal fields there are on the face of the earth, and some of them extending in almost unbroken continuation for many hundreds of miles. No inconsiderable, or even inconsiderate, rivers these must have been, thus to collect and spread out so uniformly over many thousand square miles vegetable matter for the formation of coal beds so extensive. When we contemplate an estuary extending from five hundred to a thousand miles in length, with its corresponding breadth, into which a river emptied and at certain periods overspread its bottom with vegetable product many feet thick, what are we to think of such a river, or of the country from which it could have procured all this supply? To say the least of it, there is certainly no such river or country now-a-days; and whether there ever could have been, we have these extensive coal beds notwithstanding.

We have thus noticed these theoretical schemes entertained by geologists for the origin of coal fields, but would conceive it worse than a waste of time to introduce argument in refutation of what is so evidently self-convicted of absurdity; for the condition precedent of such processes of production, if even conceivable at all, are such as nature never could have instituted and be that same nature we are now contemplating; her rules of conduct comprehend no such conditions or casualties as those which theoretical geologists contemplate as being productive of coal beds, and other rocks therewith interstratified.

The process which was in the most perfect harmony with principles and products must have been the only one which nature could have pursued in the production of this class of rocks, together with that of every other, for she as unity could have had no two ways in evolving her phenomena; as a general rule, the elements that were sufficient for the production of one class must have been equally efficient in the evolution of every other, this order of carbonaceous rocks included.

In following this efficient order of nature's formative development we have found a vastly extended era in which the waters of the primitive oceans were accumulating in formative quantity, in consequence of the vast and continued accessions of aqueous matter made to our earth since it first began to form and fall upon her surface, as is evidenced by the extensive accumulations of stratified matter received at the same time, and which could only have constituted the most energetic or comparatively small nucleus matter of these coalescing and contributing bodies, the aggregate of all constituting the strata inferior to the coal measures, and their vast comparative envelopes of less energétic matter contributing to the ocean, the atmosphere, and the earth's enveloping quantity, which her superior pressure could not reduce to solidity.

At the termination of this time, and the deposits inferior to the coal fields proper, we may assume that the waters had accumulated their maximum quantity and the ocean its utmost extent of elevation, in consequence of the aqueous contributions to our earth exceeding the appropriations to her internal processes; but now the period had arrived when a reversed order of things must have intervened; for, as nature tells the tale, the time had now come when the appropriations to internal processes by affinitive assimilations and associations must have caused such exhaustion of the aqueous matter of the ocean as brought about a general and progressive subsidence of its surface level, which was prolonged through an immeasurable extent of time, before aqueous contributions became again in excess, or greater than the quantity assimilatively appropriated in the consolidating rocks.

This general and progressive subsidence of the ocean would necessarily begin to expose the most prominent portions of the earth's unequal surface to the sun and atmosphere as dry lands, and now that atmosphere being formatively conditioned for the sustenance of vegetable life, there would follow the first forms of that terrestrial flora which has subsequently overspread the face of the earth. From these formative islands, or first emersions of solid matter from underneath the ocean, the waters would continue to recede, thus exposing the more prominent portions of this unequal surface of sea bottom, until there appeared the first plains or basin-shaped depressions suitably conditioned as a foundation for the first-formed coal seams.

Vegetation having long flourished in occupancy of the heights and declivities surrounding these plains, would follow the receding waters and overspread these exposed bottom lands, and thus be in a condition to originate the first or most inferior coal seam.

This recession of the waters from the lands, as a general rule, would necessarily be subject to many partial intermissions; for while the earth was yet receiving her accessions of solid and other matter, this general recession of the waters could not be uninterruptedly progressive, because of the occasional coalescence of bodies with her ocean and atmosphere, and the solid and other matter thereby contributed. These accessions, during the period of this general recession of the ocean, is proved by the very deposits now found in these coal fields, intermediate of the coal beds, for here there is abundant evidence of the alternate emersion and immersion of these vegetable-bearing plains or basin-shaped depressions, now the recognized coal fields of geologists.

Thus in place of the upheavings and down-sinkings of these extensive areas of our earth, or the extensive rivers and their periodical transportations of vegetable matter from some extensive countries of which these seem to be the only vestiges that remain, we have the alternate swelling and subsiding of the waters of the ocean, caused by the inequality of the formative supply, as received from contributing substances, and its exhaustion by the formative substances fabricating themselves into rocks, and all this during a vastly prolonged period of general subsidence, when the new-forming earth may be expected to have affinitively appropriated no small quantity of the constituents of this substance. This increase and diminution of the waters, from which we deduce the origin of the coal measures, is to be classed as no speculative theory, for here we have all the relative facts ruled into the most perfect harmony with each other; no overstrained inferences in thus deducing these phenomenal facts in all their relations. They become self-established truths that are unsubvertible, as in conflict with nature they can not be. The only consideration to which they are opposed is man's erroneous conception of the intransmutability of water; but this can not be of much consideration, seeing that they are so often in error. While mankind are aware that there is a vast ocean of water on the face of the earth, they are altogether unaware of the way in which it was originated, or at what epoch of our earth's formative process it was introduced, and not fully informed as to what purposes it is applicable. There is at least a possibility that they may be mistaken with respect to its convertibility, and that they are mistaken there are proofs transpiring before our faces every day, which it is now needless to name.

After these coal-bearing plains or depressions had, for certain continuous periods of time, been left by the ocean, and exposed to the action of the atmosphere, becoming thereby productive of vegetation during these long intervals of repose intermediate of meteoric accession or general elevation of the waters, they would, on the further acquisition of such bodies (particularly in their proximity), be overwhelmed with their matter most subject to solidity, mixed, as it would be, with that washed down from the surrounding high lands and sloping hill sides by the quantities of water that would at the same time form and fall, consequent from the aqueously disposed matter contributed by the same coalescing substances. These accessions of solid matter being but comparatively small in proportion to the aqueously disposed matter contributed by the same meteoric substances, would necessarily cause a partial or general elevation of the waters, so that these vegetable-growing plains or depressions would be submerged in seas holding the most of the solid and newly acquired matter in suspension, because of its yet impalpable conditions, and the very agitations of the waters consequent from the coalescence of such substances.

As tranquillity ensued, this suspended matter would subside to the bottom of these seas in what we may call meteoric mud, whose plastic character would be well conditioned in many cases to involve vegetable forms without much injury to their delicate structures, and so transmit to all after ages a truthful record of such forms as flourished in the floral kingdoms of the earth in those primitive times.

These meteoric accessions may be considered as having been very variable, and affecting certain portions of the earth more than others; but when they were considerable or general, the formation of water would follow in abundance, and fall in such floods as would raise the waters in the regions where these coalescing bodies fell. The new-formed water flowing off in equalization would to some considerable extent wash down the matter of former deposit from prominent situations, and spread it and the vegetation to which it had given birth over the lower plains, and over this last meteoric mud or incipient coal seam. This vegetable-involving mud which first fell is by no means to be regarded as the whole of the solid precipitate received from the coalescing substances at the time, for only the first received could have preserved this character, because the new-formed waters, in their fall and flowing off, would disturb deposits in more exposed positions and mix them up with these new accessions, and so metamorphose their character that they would become more and more unlike that which first fell.

Now these deposits, mixed up with the matter of the mountain slopes (and perhaps their broken-down vegetation), and spread over these forming coal fields, would make up the intermediate rocks now found between the coal beds.

On a farther recession of the waters from the most superior of these deposits, they would again become overspread with ano'her coal-originating crop of vegetation, to undergo a like process of submersion by mud and marine or terrestrial deposits as before; and how many times this process was repeated would depend on the elevation of the fields and the several accessions of matter to each while the sea was oscillating in the parallel of their respective plains on its general recession from its maximum height to its lowest level. Thus we perceive the most inferior member of the most elevated coal field would become the first-formed coal strata in the earth whose floor or ceiling could possibly contain a vestige of vegetable production. The repeated formations and fall of vast bodies of water, causing an oscillating action of the primary waters during the period of subsidence, together with the operative effect of the ocean waves, particularly during such commotions, would necessarily have a tendency to wash down the deposit of this period to the lower levels, now characterized as coal measures, and thus account for the position and character of this particular order of rocks.

We do know that the general depression of the primary waters must have been from the greatest stratified elevation now found, for these bear evidence of its presence in their formation, by the marine relics they contain.

We likewise do know they must have receded below the level they maintain at this day; for we have coal strata accompanied with the impress of terrestrial vegetation that are yet below the level of the present ocean.

By this we see the coal strata could not have been originated by vegetation of equal antiquity; and the most elevated coal fields must have been the first formed, though this does not follow as a positive rule; for the most elevated may have been of the most recent origin. And even as individual members of one and the same coal field, the lowest seam of the series may have been of the most ancient origin of all coal beds, while the highest members in the same series may have been the most recent.

This possibility would follow from the fact that the inceptions of the coal beds were usually caused by the submersion of the vegetation occupying the plains, consequent from the oscillatory movement of the ocean while the primary waters were receding, and thereby alternating themselves with dry land till they gained their lowest level, to rise again during subsequent accessions of more considerable magnitude; and as these coal measures were formed during its general subsidence, many of them would receive additions at future epochs, when they were again immersed beneath the progressively accumulating and swelling ocean.

These oscillations of the ocean-level may at first sight seem but another speculative notion got up to explain circumstances for which other systems fail to account, particularly when there is so little evidence of such subsidence of the ocean at the present time; but if we reflect, that in early times, when the earth was receiving her stratified accessions, we will perceive that they could not have been conditioned as matter now is; it could not then have been characterized by crystals, coals, sands, or conglomerates, for they are such characteristics of matter as must have been acquired since these accessions were made to our earth.

If an illustration of the importance of water in the process of solidification were wanting, take the hardest known substance, viz., the diamond, and withdraw from it the constituents of water, and at once it falls into dust. Do the same by solid rocks of any sort, and they would be solid rocks no more. We have no reason to suppose that artificial analysis can recompose again into water all of its constituents which have been transmuted in character and transformed into solidity by the affinitive forces of formation. We have already considered the convertibility of water into lime, and if such is possible in this instance, it may be admitted in every other.

Now, as these facts remain no less the truths of nature, although not admitted to the extent we contemplate, their reception is altogether essential in solving these and many other important geological problems, which are altogether inexplicable on any other principles.

We have the most undoubted testimony that the most elevated lands were at one period beneath the ocean; and we have the same unmistakable evidence of the production of terrestrial vegetation on lands now below the sea-level; and only by following with precision the finger-posts of nature can we arrive at the right cause in either case.

Although geologists in general adhere to the heaving-up and sinking-down system of the lands themselves, against the strongest evidence of the strongest power in nature (the immutable principle of their own gravitating force, which we find to be the originator of all power), we will not despair of getting assent by sensible minds to a system having such a root as is opposed to no power or principle in nature, but is in reality the expounder as well as the originator of all power, and is in every particular parallel with its product in the phenomenal expression which it gives to nature, and from which has followed both the formation of waters of the ocean and their transformation into the rocks of the earth.

Let this proposition be admitted, and many of the impenetrable obscurities now involving the paths of the physicist will pass away. It will no longer be a mystery that the ocean is now so far below the monuments it erected in former days as a memorial of its presence, and the alternations of fresh water with marine deposits will no longer be an unexplained problem; nor will the geologist any longer feel surprised that the lands, after having been left to vegetation, should have been again ingulfed in the deep seas; or that the ocean may even now cover lands that have been exposed to the atmosphere and prolific in vegetation in bygone ages; or that mountains and chains of mountains of rocks may be built up in the midst of the ocean by insect artificers, who get their materials on the spot, and by no other evident means than their own power of metamorphic production.

This proposition of the convertibility of water not only explains all these problems, but likewise the cohesibility of matter in rocks; for no conceivable mechanical pressure could by any possibility have converted their own impalpable matter into such solidity. While the earth was accumulating her stratified portion, water must have been present, as we find unmistakable evidences; but in the more primary rocks on which they rest, the evidences are wanting only in so far as they are crystalline substances. But this characteristic might have been acquired at any period subsequent to their deposit, that being a consideration of time and circumstances, and only took place after their constituent matter became well saturated with the aqueous substance. In consequence of the all-pervasive qualities of water, it must have saturated all substances previously deposited; and this alone would employ vast quantities, and would thus afford to molecular affinities the opportunity of associating it in solidity. The strata of the earth not only indicate the presence of an ocean while they were being deposited, but they contain the chroniclings of the conduct of that ocean while they were in incipient formation. We find in the stratified rocks records of long periods of profound tranquillity, when organic life in the form of plants and animals luxuriated in their generations in all the pride of prolific existence. But we likewise find a record of sudden periods to these conditions, and find the crawling creatures and living plants often locked up as monumental mummies to tell the tale of the sad catastrophe that befell them to intelligences then in the womb of the prospective.

We often find that these creatures, in their last life-struggles to extricate themselves from the entangling sediment fast settling down on them, have forced their way well up into the strata by whose rapid deposit they were ultimately overwhelmed. The deposits falling layer upon layer would soon be heaped high above them, and leave large spaces where there is no vestige to tell that life had been.

Chapter Fourteen.

Meteoric Accessions—Stratified Deposits—Oceanic Currents—Arrangement of Strata—Shales—Coals—Dikes.

When great geological groups are historically studied for their chronological records, their lithological monuments must not be interpreted to mean that for every stratified bed there must have been a special meteoric accession and deposit of that particular kind of matter which now characterizes the respective strata; the affinities of matter in subsequent time would be found all-sufficient for that. But from fossil-bearing beds to fossil-bearing beds the intermediate matter may be regarded as accessions made by meteoric bodies in solid contribution to the groups under contemplation, between such times of repose as would have admitted marine creatures or terrestrial organisms to have occupied the situation of land or sea where their remains are now found. This intermediate matter may have been contributed by the coalescence of one or more meteoric bodies with our earth, so that the time between them did not admit of a recolonization of the region with organic forms of either sort.

These intermediate beds may at times contain organic remains of former times and remote regions, which have been torn up and transported (by the deluge of water formed from the meteoric matter contributed as a fluid accompaniment) to these newly received masses of matter. Examples of this may be found in the vegetable forms in the intermediate strata of the coal measures, by having been brought down with the detrital matter of the mountain slopes, and altogether mixed up with newly received matter in heterogeneous mass, whose separations and assimilations into distinctly stratified beds time and its own constituent affinities would ultimately determine. The matter of these coal fields, not having been carried over slopes and declivities so much as most other deposits, may be more readily studied (as examples of the general system of the reception of matter and its subsequent disposition) than those portions can be which have been torn up from elevated regions and tossed over acclivities by torrents and deluges, and so mixed up with more recently received matter.

The coal measures may, as a general rule, be regarded as deposits wholly limited to what are, or have been, basin-shaped depressions of land or sea-bottom, altogether, or in great part, inclosed by deposits of a greater elevation and extent by which they were surrounded. The consequence of this form would make them retentive receptacles of all such descending meteoric matter as should fall within their margins, as well as that which was brought down from their own acclivities. Hence, as will be evident, there must have been very considerable commotion caused in these basins during such accessions, judging from the solid deposits elevating their bottoms, and from the excessive formations of water accompanying them. The necessary effect of this disturbance would be the washing down, in some degree, of the matter from these marginal elevations and mixing it with the newly acquired quantity, forming lime; sand, clay, and conglomerate beds, interstratified with coal, and at times inclosing considerable fragmentary parts of vegetable forms which grew on the hill-side. But though such positional conditions may be considered to have been the most favorable for coal formations in general, it does not follow that other dissimilar localities could not produce coal beds.

Although not an indispensable prerequisite, there are reasons why the depressive form of coal fields should be conducive to the greatest number of seams in a series, if not of a greater quantity of coal. And although coal beds may have usually been originated by a stratum of vegetation on the ground where it grew, or by its presence through some transferring process, we shall find that the presence of solid carbonaceous matter in any considerable quantities was not indispensable to the origin of coal beds. Whatever may now be their extent and thickness depends on succeeding circumstances, which we will now consider. The quantity of matter contained in such basins will best account for the general subsidence of the ocean to its lowest level during the epoch of their formation; for when we consider the amount of previously deposited matter that must have been mixed up with these new quantities, the accessions must have been comparatively small during this long epoch, which accounts for the limited acquisition of water and the general subsidence of the sea.

Although the coal measures, when considered in the aggregate, are in themselves extensive, yet they are but little when compared with the whole surface of the earth; and their depth, when we have deducted the previously deposited matter, is small, compared with the accessions of stratified matter made before and after their reception. Therefore the requisition of water at this time would have so far exceeded its acquisition as to reduce the ocean-level (by oscillatory movements of change) from the most elevated to its most depressed position.

The proofs of this very recession of the waters, in contradistinction to the spasmodic upheavals (to which the earth is supposed to have been subject), will be abundantly established by the natural and orderly manner in which the coal measures were formed, they being but the simple process of cosmical progression. They are found, it is true, as respects the different parts of the earth, in situations variously elevated, but still below where the ocean has been; and even in the same country they may not be found on the same relative level, and notwithstanding the ocean has been above them all, they, with little exception, contain traces of terrestrial vegetation. There must have been, therefore, at the epochs of their respective origins portions of land above the then existing ocean-level, and somewhere in their close vicinity; for the texture of these plants is often found in such preservation as precludes the possibility of their having been transported far.

All the stratified deposits of the earth (not even excepting the coal measures) must have taken place in salt or fresh water, otherwise they would not so invariably have those characteristics so readily attributable to water.

It may at first sight seem incomprehensible that terrestrial plants (that could not bear transportation) should be found in such abundance imbedded in aqueous deposits at the bottom of deep seas. This can be explained by the ocean having subsided below the lowest depression of the coal regions, marginal inclosure of elevated land. These waters, thus left in isolated depressions, would more and more recede below the summit of the hills surrounding them, and in process of time they would dry up, followed in their descent by a growth of vegetation whose prototypes had long previously flourished on the summits and acclivities of the more elevated lands. There may have been several such depressions and coal-field formations in any widely-extended region of country, such as the coal basins of England for instance. The consequence would have been that these basins must have become the receptacles of such meteoric accessions as were made to that part of the earth subsequent to the time the ocean was reduced to a lower level; for the floods of new-formed water would flow down the declivities, carrying with them the fragments of forests and torn-up vegetable forms that are so often found plentifully interspersed in the rocks that are intermediate of coal beds, these torrents charged with this solid matter in solution, or in mechanical mixture, filling up the depressions of the earth, and depositing the more solid portions in beds on the bottom, where the plants previously flourished; and when the accessions of water and sediment were more than these basins could contain, it would flow off (by the most depressed places in their margins) into the common ocean, which might occasionally become so elevated by augmentation as even again to invade these plains.

Thus it is evident that nothing more would have been required than successive repetitions of meteoric showers for the origin of coal beds and for the accumulation of matter for the formation of intermediate rocks, even if a stratum of vegetation had been essential for the origination of every respective coal seam in each series.

We may certainly count on a peculiar condition of things and circumstances, during the immensity of time required for the ocean to recede from its highest to its lowest level, by this particular appropriation of so much of its matter by the consolidating rocks, the most peculiar circumstance and cause of which being the comparative cessation of contributions from space during this period when contrasted with the receptions of preceding and succeeding times. The cause of this general suspension may be traced to the relative positions of the aggregating masses in space, and the difficulty of absolving themselves from the ties that there bound them; and many of them having incomparably greater distances to travel than others, and far less attractive inducements to urge them on, they therefore could not be expected to follow each other in any thing like a regular periodical succession; and many of them, even at this day, by their revolutionary movements in space, continue still in isolated independence; and the less dense or energetic the constituent matter of their respective masses compared with their bulk, the longer they are likely to escape ultimate absorption by the more legitimate members of our solar system.

These long intervals of time, when the waters of the ocean were appropriated by the rocks of the earth without such compensating accumulations from space as were equivalent, would cause all the deposits of this period to assume conditions in accordance with a receding ocean in the manner just contemplated in the coal measures, which were the recipients and perpetuators of the recorded impressions of plants which must have been produced on the dry lands in their immediate neighborhood.

If it should be questioned why these contributions received at this time by our earth could not as well have been made to lands long and high above the ocean-level as that they should have been received in these basins, we answer, that since the earth's envelope had become sufficiently compressive to condense aqueous constituents into water on their reception, no contribution could have been a dry one; and it would necessarily follow that every new accession would flow down from the high lands and acclivities, carrying along much solid matter and passing it into the general ocean or the isolated seas they encircled, some of which latter being thereby transformed into coal fields consequent from such accumulations.

These deluges would not only take along the solid matter thus contributed, but would likewise remove much that had been accumulated before they rose bove the ocean, thus reducing these prominences to a lower level, and denuding them of their vegetation. Thus we perceive that all matter contributed by external bodies in coalescence with the atmosphere must have been unable to repose upon the hill tops or sides while there was such a rush of the forming and falling water down to the sea-level.

There is another significant and very important fact to be inferred from these coal formations as well as from preceding deposits, viz.: the stratified rocks originating in these deposits being so generally in planes of persistent parallelism, and conformable with the inclinations, contortions, and curvatures of the floors on which they fell, this could not have been unless matter had existed in such impalpable powder or partial solidity as to be equally disseminated while in temporary suspension in the waters through which it had to pass; for it will not be supposed that sands and gravels, or any such coarse ingredients as constitute many of the rocks, could have been formed before they fell; or that they could have been so disseminated in the sea as to fall in beds of such uniform thickness on the uneven surface over which they were spread. Nor can we conceive of any force that could have separated and spread out the alternating kinds in such thicknesses as accorded with the heterogenous quantity at the time procurable, or that could have changed or substituted another sort in progressive passage for the completion of the same parallel bed or plane of strata. There certainly is no conceivable action of the general ocean or of the isolated sea that could have furnished and spread out the matter thus forming the alternating strata, or that could have effected their distribution in parallel beds with their frequent insensible passages from one condition of formative structure to another.

Much is said by theoretical geologists about river and oceanic currents having procured and transported to its present place this and that kind of matter, from this and that quarter, with all the complexity of alternating action indicated in the origin, transfer, and deposit of all the kinds and quantities composing the long catalogue of alternating kinds which constitute the members of the several geological series of rocks.

Now we should suppose, if the absurdity of their system was not self-evident, that nothing further would be required for its total refutation than the very impossibility there is in the explanation of this law of currents; for had it been possible for currents and casualties to have caused these conditions and relations, there would be infinitely more difficulty in accounting for the origin of such currents than for the conditions they are intended to explain.

Between the process of inquiry we are pursuing and that which calls for such currents and casualties, there is this difference in the rocks and their relative characteristics and associate relations: we have the positive expressions of nature's own acts presented as truths in tangible form, which she must necessarily have produced by a process; therefore the nature of this process is a problem whose elements must have been equal to these phenomenal evolutions, and hence susceptible of a practical solution. But the currents and casualties by which theoretical geology undertakes to account for the phenomenal expressions of nature as presented in the rocks, being but creatures of imagination, having no foundation in fact, any circumstances supposed to cause these hypothetical currents being of precisely the same character, can present no possible problem whatever for solution, the whole being a misconception of the facts.

Instead of such contemplated currents and eroding forces as would have ground down previously existing rocks and transported their ruins to rebuild other stratified systems, these primitive oceans must have been in the most profound tranquillity, from the coincidence of the plane of the earth's rotation with that of her revolution round the sun not yet having been disturbed to such extent as would in any great degree interfere with uniformity of temperature, together with the little exposed lands and consequent uniformity of sea-surface.

If the quiescence of the primitive waters are not sufficiently inferable from these conditions, we have still further proof of it in the persistency of early deposits. Whatever may have been the irregularity of the sea bottom over which they were spread, the stratified beds follow in remarkable conformity all the inclinations and deflexions of the foundation on which they were outspread; this could not have been had there been any such currents, although, as we have already seen, on the reception of deposits there were large accessions of aqueous matter at the same time, thus causing commotion and local elevations of the ocean; but this elevation would equalize itself by flowing off in radiated surface-currents that would not much affect deep seas, though they might be a little felt in shallow waters.

Having thus far followed the effectivity of nature's formative processes, by which much of the earth's stratified matter has been produced; having, we say, followed their lithological chroniclings, we find recorded the geological epoch at which the waters of the earth must have attained their highest summit-level, and that level we find to have been far above the most elevated coal fields. We have likewise found why the waters receded below the lowest of the coal measures, and that they were for a time below their present level. But whether these coal measures be high, low, or intermediate, as respects the present level of the ocean, they contain in themselves a perfect record of their own originative processes, as well as of many other important cosmographical acts that transpired during this general recession of the sea.

The reception of matter for the coal fields and other systems of rock, is a different consideration from the structural formation of coal measures and other geological systems in their formative characteristics. We have already contemplated the circumstances under which these accessions were received and deposited, which constitute the coal measures, and we have to infer that the periods occupied in their precipitation must have been comparatively short, depending on the condensation and specific gravity of the matter received, compared with the atmospheric and oceanic mediums through which it had to pass. These accessions being of meteoric bodies, variously characterized and impinging at irregular periods, can not be expected to have furnished matter of precisely like character with that previously contributed by coalescing bodies.

But there is nothing to justify the inference that any of their affinitive forces, powers of compression, or conditions of formative effectivity could have constructed any of their molecular forms into solid and sensible particles, such as grains of sand or conglomerate ingredients, and in this manner have been precipitated to the earth. The matter furnished by these meteoric substances must have been in showers of impalpable particles variously conditioned, so that when subjected to the compressive powers of the earth's enveloping medium and the affinitive forces in proximity, it was prepared to assume in process of time its present characteristics. It is not to be supposed that these structural changes were rapid, or that it at once assumed the conditions it now has, either in the nature of the ingredients or structure of the respective strata, or in the separation or assimilation of matter in separate beds, as in the several associate members of a series. We have remarked that the periods of reception were comparatively short, though there may have been almost immeasurable intervals of time between the first stratified deposit in a coal field, and the last received matter for the completion of the same coal measures.

These meteoric accessions of matter that make up the stratified structure of coal fields, as we have seen, must have been to some extent in heterogeneity with other matter washed down from elevations; but we have no reason to infer that these eroded portions were consolidated fragments of rocks rounded into pebbles, for though the intervals between the accessions might be long, the time required for transforming this heterogeneous mixture of mud into solid rock must have been much longer still. And however that process may at times have been expedited in some of the associate beds, the present character of coal measures and other geological systems has been undergoing affinitive form of structure from the first minute of deposit until now.

After the accessions were all made, they were but what we may call the raw material for subsequently conditioned rocks (and much mixed and blended at that), from which all the groups anterior to the new red sandstone deposits were ultimately to be constructed, but they were by no means the groups themselves conditioned as we now find them; these are the effect of constituent affinities operating through countless ages in their constructive capacity and transformative effectivity. In contemplating the several associations of rock contained in any of the geological series, and particularly that of the coal measures, if a dogged adherence to the doctrines of the theoretical schools did not obscure the perceptions, it would readily be discovered that the bulk of the matter from which these systems have been fabricated, must have had more of a cotemporaneous origin than their several strata would signify, which could not have been deposited in their several kinds successively, as the systems now seem to indicate, and as is usually supposed and insisted on by geologists. Besides the alternating beds of sandstone, shale, and clay, which usually constitute the coal measures, there are often found connected therewith the several members of the trappean family of rocks, either in intermediate beds, with as much evident claim to a cotemporaneous place as coal or any other of the associate members of the same series, or in dikes, intersecting the strata at every or any inclination to their planes of stratification, and whose matter has as much claim to have had a cotemporaneous insertion into fissures according to the usual processes, as have the dikes of sandstone or clays that are often found intersecting coal measures.

Because the affinities of matter have formed from the general mass a parallel bed in which there are no further traces of stratification than this parallelism, can that be assigned as a sensible reason why there should be attributed to these beds a subsequent intrusion, and that their matter must have been molten lava? We assume that no sensible person, on serious reflection, will be found entertaining so absurd an idea, as that continuous dikes in coal fields were filled so discriminatively by the infiltration of sands or clays already formed to the exclusion of other matter from these chasms. Therefore, if the primitive matter occupying these openings could have been collected there in virtue of affinitive forces, and could have taken the form of sand or clay in accordance with the assimilative forces and forms first originated in such fissures, we see no reason why this matter could not as well have assumed the character of a trap dike had its affinities been so disposed, for the molecules forming these intersecting walls, whether of trap clay or sand, when purged from the affinitively forming strata into the opening fissures, could as well have been in condition to compose the trappean structure as any other; and if the molecular affinities of fused matter could have formed trap rocks, we can not see why the molecular affinities of unfused matter as favorably conditioned could not have done the same thing. While fusion implies a previous cohesion of the molecules of the fused mass, we are certainly at liberty to infer a condition before the molecules could have been subject to any cohesive constraint, and then we might suppose them at least equally qualified to assume the formations that conditions required and that is usually attributed to fusion. The coal beds, when cut by and in contiguity with these trap dikes, are sometimes found to be different in their lithological texture, and therefore supposed to have been thus metamorphosed by the effect of highly heated and fused matter intruded as trap dike.

Now if this change of the contiguous coal seams, or other rocks, is attributable to heat rather than affinitive action, to what shall we attribute the changed complexion and character of the sandstone and shale beds when in contiguity with the coal strata, as constituting their floor and roof? They are often so undecided in texture and character, as must be accounted for by some other cause than heat. How, too, can such action account for the alternate widening and narrowing and change of lithological texture of the intruding wall of trap rock itself as it intersects the several strata of an associate series?

Had there been general chasms caused by dislocations of such associate strata, as is usully supposed, by what rule of law, of a force, or rupture would there have been more intermediate space between the dislocated portions of one strata than those of another, or even in a passage through the same bed?

In beds of rock superimposed upon each other, and rent apart (as is usually supposed by an eruptive force), a fissure might diminish downward to the foci of force through the whole incumbent rocks in regular progression, and in proportion to the extent of upheaval; but we can not imagine a possibility by which it could have been made to alternate in width, or to change the character of the included wall in its way along the chasm, as is often the case with dikes.

In attributing the structural formation of rocks to affinitive action, we find ourselves beset by no such negative facts as must necessarily abnegate every theoretical system assigning to them any other origin; and we do not conceive that finite wisdom is wisely exercising its functions when it entertains the idea that Infinite Forethought could have imparted the affinitive forces to matter for so little purpose as to leave them unable to fashion matter into the formation of the earth's rocks without fire and fusion, rupture and convulsion, originating in unaccountable causes for which no calculations can be made. It would be well (as we say again) for philosophers and physical thinkers before they count so much on convulsion as the means by which so many of the phenomenal facts of geology have been affected, if they would first come to some determination respecting what these convulsive forces are, how originated, and by what principle governed and restricted to the accomplishment of this or that feature of phenomenal exhibition, as regulated by rule. We do not suppose they wish us to think that physical nature, in her formative character, was but the effect of fortuitous forces of informal or uncertain action.

The very affinities furnished to matter for physical measures forbid the idea of such rupturings, rendings, uptossings, and turnings of the earth's stratified rocks as a cause for the phenomena assumed to be attributable to them; though the rocks are dislocated, twisted, contorted, and inclined at every angle, conformable or unconformable, that is no reason why the simple, truthful, straightforward, and effective forces of nature found in the molecules of constituent forms themselves should be overlooked or rejected as having caused such conditions and systems of force, and substituting the most unsatisfactory and absurdly extravagant in all their relations as a revolutionary rule of action, by which the conditions of the several formations in the physical framework of our world were to be regulated.

Had the object of these theorists been the converse of what they essay to teach, that is, to mislead the physical inquirer, they could not have been more successful, for their speculations invariably wind the investigator in webs of inextricable bewilderment, so as totally to obscure the effective processes of nature, and prevent all possibility of solving her problems. Whereas, by strictly following what are really the formulas of nature's affinitive action, the physical inquirer is in no danger of misdirection, for they must necessarily resolve themselves into the very phenomena for which a cause is thus sought, so that being right in the rule we can not be wrong in the result.

Assuming, therefore, in continuation of material progression, that its radical forces are the only rule of action, as mutually operating among the constituent molecules of a mass, let us see how it will apply to the problem of a coal field, or any other group of rocks, great or small, or severally conditioned.

We have already contemplated the time and circumstances of accumulation in and by which the masses for the coal measures were deposited, and that as a consequence of the mutual effect of the affinitive action of matter whose combined energy we recognize as gravity.

We have now only to notice the formative effect of these affinitive forces in fabricating these mixed masses of heterogeneous matter into the coal measures in question; and as the molecular infinitesimals of these heterogeneous masses on their reception must have been differently conditioned and circumstanced, and having different degrees of affinitive force acting in the inverse ratio of the square of their distances apart, and having different susceptibilities of assimilation, it is easy to perceive that affinitive action would be unable to operate in equability across the whole deposited mass, so as to form it into a homogeneous rock. The mixed forces and forms in the mass would necessarily subdivide it into planes of parallelism most convenient for their own effective powers, their distances being regulated by the affiliating forces of the molecular forms of the constituent matter as first spread out.

These planes of parallelism, or stratums of strongest affiliating force of each kind, would situate themselves exactly intermediate of the least forcible molecules of the other kinds. Thus the differently conditioned molecules of a mass thus heterogeneously deposited would be made to change their places with each other, and assimilate in parallel beds, having their central planes of strongest affiliating force as the extended foci of their formation, and intermediate of each other. Hence, to some one of these alternating stratums of strongest force all assimilative intermediate matter would tend, so that by this reciprocal change of place all the matter of a mass would ultimately become, in a very great measure, separated, assimilated, and associated in subdivisional beds of alternating structural character. When we find the affinities of matter so readily forming a rose, why may they not in an infinity of time have formed a rock with all its structural characteristics?

Of these assimilative processes, forming stratified beds of dissimilar character on an extensive scale, we have evidence in many of these respective beds by a miniature sort of subdivisional association in the variously lamellated characters of the larger beds, and in color and texture carried to such extent as the feeble forces could effect. Hence in the structural formation of many of these larger beds, geologists have an opportunity of studying the effect of the affinitive forces in the formation of these miniature representations of the larger systems, or groupings of rocks, the only difference being that strata in a bed are not so often characterized by so abrupt divisional plains, but pass more progressively into each other, at the same time retaining their general cohesion. We know no reason why information regarding the structure of rocks should not be sought for in the rocks themselves, for they certainly contain sufficient record of their own originating processes carried out in characters most convincingly conspicuous.

If we recognize the broad, self-evident principle that all sensible substances whatever only become such through their own affinitive forces, subjected to the pressure of the earth's envelope, why should we deny the application of this rule to rocks?

Mechanical action may have made sad havoc in the homogeneity of the primary arrangement of molecular forms by causing promiscuous admixtures. But the life and action of the whole material system consists in disturbances, restorations, and reformations of affinitive conditions. Were it not for these, the constituent affinities of matter would speedily resolve all things into the frigidity of death, and we see no reason why the materials of rocks should have an immunity from this general law. The affinities of their matter could neither have been killed nor paralyzed by the mechanical force that demolished the first forms, fabrics, or admixture of matter, and the molecules would still continue affinitively active in a reconstructive capacity, and form rocks and systems of rocks, necessarily reconstructing themselves in stratified forms, because of the heterogeneity of the molecular forms from which they were made, and in obedience to the exertion of native affinities endeavoring to reduce this heterogeneous matter to rule by assimilation, in satisfaction of their affiliating functions.

When either of these affections had so far succeeded in forcing any structure of matter to any thing like a perfect homogeneous assimilation, such would constitute a bed with little or no trace of stratification. All its molecules being of one character, there would of course be no difference in color or texture, and no cause for lamination. It could have no distinguishing characteristic other than constructive cohesion or its crystalline texture. Still these unstratified beds are as much the necessary consequence of the primary conditions of matter and its manner of deposit as are the stratifications themselves.

We find this form in the trap rocks and other unstratified beds, dikes, or veins associated more particularly in the several geological systems whose matter was deposited anterior to the ocean's recession to its lowest level; which includes the deposits associated with the coal beds in which these rocks are often found very abundant.

The finely pulverent or insensibly solidified deposits of these primitive times, before matter had assumed sensible form, having taken place in tranquil seas, and being generally diffused in their waters, would necessarily settle down in conformity with the ocean bottom (however irregular that may have been) as a general rule; still circumstances must often have caused exceptions to this. The constituent forces conditioned to resolve the divisional plains may not, in all circumstances of deposit, have been in position with the curvatures, as these forces could be constrained by no rule but the regulation of the molecules they are a part of; and the several affinitive molecules could not have been at all times so equally disseminated among each other, as to have caused parallel action in longitudinal planes, but may have been so conditioned as to cause any positional attitude of strata, however contorted, inclined, or even vertical their laminations or divisional planes may be; still it is certainly more sensible even to suppose them the effect of affinitive forces than to imagine them consequent from mechanical action.

The aggregate affinitive impulse tending to the earth's center unquestionably had much influence in depositing the sedimentary matter; but it could not have deposited it in the stratifications we now find. We may easily discriminate between the action of gravity, or that force tending to a common center, and the action of reciprocal affinities, affecting the approximate molecules of the deposited mass. One has relation to the general form of the earth; the other has relation to the forms which constitute the earth. The aggregate and abstract affections of matter operate, as to a common center of all, indiscriminately; and in this general application are the forces which form a world; but in their more special applications they are the forces which form the distinctive substances of which the world is the aggregate; and in the construction of the earth's strata these forces operate reciprocal interchanges among the constituent molecules of the deposited mass, operating on its matter from as many divisional planes as there are strata in the depth of the deposits, thus determining its stratified beds, of whose forms these subdivisional affections were the force, by resolving into each respective plane the molecules over which their assimilative faculties were most effective.

These formative affections could not have been restricted in their action to any given direction, only so far as gravity had influenced the deposit; but mutually and socially they would have been equally effective in any direction. We can not see the necessity, so much insisted on by geologists, that stratified deposits must have first been spread out in horizontal planes. And while there is nothing to justify the inference that the mutual affections of matter can operate only in a perpendicular direction, or that they have any directional preferences, we can certainly suppose the possibility at least of deposits being so molecularly conditioned that their affinities would effect their subdivisional parallelisms in planes at any angle with the horizon; for although gravity would have its effect in the general disposition of strata, it might not rule in the regulation of their planes of parallelism, these being caused by the affinitive forces of constituent molecules in their mutual relations, without special reference to that gravitating force which is supposed to have resolved them into planes with the horizon.

Thus by what we assume to be nature's physical formula, we find demonstrated the processes by which rocks were constructed of molecular ingredients, originating in isolated substances, having their nativity somewhere within the confines of the solar system's central power; and in obedience to which power they would converge until intercepted by the earth's outward atmosphere, through which, and her ocean, the more ponderable particles would descend, the descent modifying the primary relations of their constituent matter in preparation for final construction into strata by their own affinitive energies acting under the earth's external pressure. The more ethereal the matter, the greater its facilities for molecular assimilation. The very stratification of rocks is in consequence of their molecular ingredients mutually seeking to assimilate themselves with others of kindred character through myriads of ages. The incipient germinations of strata may have been resident in the deposited masses, but their present structural development depended on the formative affinities of their own constituents; and as the formative forces are never at rest till they have reduced molecules to their rule of action, these molecules must therefore have undergone progressional transformations and transpositions of place, till primary conditions were changed into the present state of rocks. We often find nature effecting sudden formations of assimilated substances, but that is after the conditions of matter are made favorable to the effect of the formative forces, as they readily become the instruments of her will only when the molecular affections are thus unobstructed in action, which certainly was not the case when rocks were made. And that the assimilating process is still incomplete, notwithstanding the immensity of time, is no matter of surprise when we remember the obstruction and entanglements of their molecular forms in consequence of mechanical mixture, crowded impact, and solidity. Then, too, there would be difficulty in separating and expurging the unassimilating forms from solid substances. Some of these forms could neither be associated in the general formation of the beds, or expelled, and so would cause embarrassment and confusion to cohesiveness; they would be made at times to occupy positions intermediate of stratified beds, which occasions a lack of cohesion in their divisional planes of junction.

These unaffiliating forms of heterogeneous deposits often cause misconception respecting the concrete forms of the conglomerates, for such unassimilating particles being expurged from the distinctive formations often act intermediately with less cohesive effect, or are more readily disintegrated, thereby allowing the distinctive or concrete forms of a conglomerate to fall apart in such a manner as to be mistaken for the water-worn fragments of former rocks, instead of being regarded as special formations in the primary construction of certain strata. Thus we see it is at times difficult to discriminate between what was really a primary formation of distinctive concretions, affinitively constructed, and a conglomerate of such forms, agglutinated by intermediate paste or cement. This very cement itself is certainly sufficient to prove what the affinities can do in collecting and constructing matter into a cementing substance of solid rock. A heterogeneous mass of matter, resolving itself by its affinities into a series of subdivisional planes, must have very much modified their primary conditions; for the susceptible sorts in the several planes of parallelism being unequal, the appropriative functions of the most affinitive parallels would be most forcible in the same geological series, and their tendency would constantly be to enlarge their own mass by the abduction of all matter that would not so readily affiliate with the forms in contiguous rocks. With this assimilation of solid molecular forms much aqueous matter must have been associated, as all substances were saturated with it, and thereby enabled to unite in affinitive solidity with the formative quantity required; it would likewise facilitate the transit of solid molecular forms in satisfaction of their affinities; added to this is its susceptibility of decomposition, whereby its constituents were subject to be appropriated in assimilating solidity.

To this metamorphic assimilation in solidity (of the aqueous substance) much of the structural phenomena of solid rocks is to be attributed. Philosophers can not be insensible to its presence in all formative processes; and yet, because it eludes their analytical investigations when being transmuted, they are unwilling to award it the credit of having furnished much of the material fabricated by the affinities into solid rock. But nature's ways are by no means restricted to men's theoretical notions of them, and philosophers have often been known to entertain erroneous opinions respecting her processes; so it may be possible, notwithstanding their opinion, that the metamorphic assimilation of water may have been essential and largely prevalent, even in the structural formation of rocks, as it unquestionably was to their solidity, and it may have been much more extensively employed in some sorts than in others.

We have found that stratified systems could not have continued stationary in their constructive characters while the affinities of their matter were in incessant activity, and their molecular forms still a mixture. Hence the subdivisional beds of any incipient series must have been subject to mutation, both in quantity of matter and quality of construction. Some of them would swell in thickness beyond the more primary subdivisional planes by appropriation of matter from exterior to themselves, while others would be proportionally diminished by the abstraction of their unassimilating molecules. But how much soever this mutual transference of forms may have affected the respective strata of any given series, it could neither augment nor diminish the quantity of matter in the general whole. The amount would remain the same, however the particles might be transposed or transferred. But when we admit the convertibility of the aqueous components into the constituents of rocks, we have no rule by which to estimate the comparative quantity converted to the construction of each particular form of rock.

Still there are in some of the stratified beds circumstances of mutability that can be calculated on with safety; for many extensive limestone strata are found to have originated in comparatively inconsiderable stratums of shells, leaving no other inference but that these shells formed the affinitive stratums which originated the limestone beds, by being the attractive plane to which affiliating forms would transfer themselves in cumulative convergence, thus progressively swelling the stratums into considerable depth by their own constantly increasing affinitive action. These beds may often have accumulated to considerable extent, while at the bottom of tranquil seas, by the active effect of insectarian organisms.

These beds, having shells for their base, must have been originated intermediate of receptive deposits, in times of tranquillity, and their subdivisional parallelisms that are destitute of fossil remains forming the general strata, must have accumulated subsequently; for the creatures that inhabited these shells must have been generated and propagated on the sea-bottom in time of quiescence, before the incumbent masses of strata were precipitated over the parallels they occupied, or any of their constituents transformed into lime. Now by what system of coincident circumstances could the first falling substances, in which these shells are involved, have been beds of limestone, and they again succeeded by other stratified beds of differently conditioned matter? As there is nothing from which to infer that a bed of shells could have enforced a fall of limestone matter upon itself, or that matter could be lime before it fell, we must conclude that the limestone strata (having a platform of shells for its originating plane) must have been the progressive effect of affinitive action, transforming the received matter into lime, and having its inception in the first organic forms occupying the plane of the deposit now transformed into limestone rock. There is certainly as much difficulty in the conception of these crustacean tribes being the generators of all the vast quantity of lime that exists (an idea at times entertained), as that it should be consequent from its own affinitive action. Besides the limestone beds having shells for a foundation plane, there are many others having shells more or less interspersed throughout the whole mass; but this is not proof that the whole bed is composed of shells, or of their cemented matter, after having been in comminution; but it certainly bears strong record of long periods of time between the deposits, thus allowing the movements of the ocean to act upon that already deposited, thereby removing it by agitation from the most elevated or exposed situations of the sea-bottom, and slowly depositing it over inclined plains or depressions, on which organic forms were propagating their generations in the enjoyment of life and activity. While these creatures were thus in activity they could preserve themselves from entanglement among these slow deposits of matter, thus becoming transformed into lime by the crustacean affinities of these very forms themselves, but at their death they or their exuviæ would become inclosed in the mud and shells transported from the more exposed portions of the sea bottom. But the transported deposit would not, of necessity, be lime, but must have been subsequently transformed into that substance by its own assimilative affections generated by the inclosed shells. Thus the shells and the matter in which they were interspersed must have grown and been aggregated together by slow accumulation, and subsequently metamorphosed into limestone by the assimilative effect of the shells inclosed.

But though an interspersion of shells may have usually originated limestone, we must not infer that shells were indispensable for the formation of all limestone strata. This seems a form willingly assumed by matter without much extraneous inducement, and like other rocks, they must have often been originated in their formative characteristics by the rule of divisional forces in the affinities of deposited masses without the instrumentality of shells, of which there are examples in the most primitive limestone which had an existence before the introduction of such organisms.

If we but examine a variegated marble slab, we shall be satisfied of the effect produced by affinities in the formation into rock, otherwise what could have so sensibly effected the separation of the constituent kinds of this rock? By tracing the structural formation of rocks and of their constituents, we shall find in them no exception to nature's universal law of originating her formative processes by principles altogether imperceptible, and with forms far outside the sphere of our physical perceptions. We can no more measure by our senses the initial form of any crystal or other substantive character, than we can measure that of the most rudimental molecule that originates organic structure. The incipient processes and forms are altogether unappreciable by any powers of which we can avail ourselves. The most expert analytical chemist would find it impossible to produce the most fundamental form of any substance. Every sensible particle has had an insensible origin, and the sensible characteristics of the stratified rocks could not have had immediate development; their primitive forms were adapted to different circumstances and conditions in their native spheres before impinging upon our earth, and becoming subject to her forces and affinities by constituting materials for her stratified beds. Therefore the structural texture and distinctive characteristics of the stratified rocks must be measurably attributable to the transmutative processes of their own powers of action, operating through an infinity of time, and with an affinitive effort to reduce these molecular mixtures to their most primary assimilations of stratified sorts.

Having thus far contemplated the processes which alone could have produced the present geological conditions, and could have produced them only by the ordinary progress of physical projection, we can perceive no more difficulty in accounting for the construction of a coal bed than for the formation of a limestone strata, the initiative nuclei being all that was necessary in either case. Surely if limestone strata could have originated in inconsiderable quantities of shells, spread out in the plane of their beds, we can see no reason why coal strata may not have had their origin in inconsiderable deposits of vegetable products spread out on a plane. We have already contemplated the processes by which coal fields were constructed; we have observed the depressed plains overspread with primitive vegetation, and noted the circumstances which caused their immergence in soft, sedimentary matter, succeeded by considerable deposits of that which was differently conditioned.

Such vegetable stratums thus produced, there is no perceptible reason why these vegetable parallels should not have been expanded into coal beds as readily as stratums of shells originated limestone rocks. They may as well be supposed to have formed the affinitive planes to which carbonaceous matter would in all after time aggregate itself in the form of coal, or the surrounding sedimentary matter have been transformed into carbon, as that shells should become the strata to which the carbonate of lime would accumulate. Both are equally mineral substances, formed by the affinities, and are simply but different conditions of affinitive action assumed by force of circumstances; and the mineral characteristics of carbonaceous matter in coal are no less conspicuous than the bituminous substances with which it is so often associated. We hold the differences to be, not in matter itself, but in the affinitive relations it has assumed, otherwise how came this bituminous substance so often associated in these carbonaceous beds? and these forces might as easily be such as would construct carbonaceous ingredients into rocks within the earth as into vegetation that grows upon its surface, with this ingredient as a principal constituent of their structure. Matter affinitively formed into carbonaceous molecules (we infer from its being found so plentifully in plants) is the best qualified for construction of vegetable forms; but vegetable secretions are not to be regarded as the only process by which this substance can be soldified; and if found solidified into a rock, instead of a plant, we do not know why geologists should insist on these rocks having had a vegetable origin.

All the operations of nature being intimately associated as a complex unit, matter must be the ready medium by which all the relative passages are perfected. Were there really different kinds they would never be ready in proper quantities, places, and times, when required for the several phenomena in their social relations. But as nature has reserved to herself the power of its transformation into any required condition from that of any other, there is no reason why we may not find its recognized characteristics of affinitive action as plentifully displayed in the rocks of the earth, and their origination as in the vegetable forms that are assumed to have furnished the matter for their fabrication. We admit that most of the coal beds may have had a vegetable inception, but only in so far as vegetable forms may have determined the affinitive parallels on which the carbonaceous matter might progressively accumulate in metamorphic assimilation, or affinitive absorption in greater or less quantities, as conditions might determine. Vegetable forms and impressions being often plentifully found in coal fields, and more particularly in the rocks in contiguity with coal strata, have given rise to the very erroneous idea that these coal beds are altogether a vegetable product, accumulated by some process respecting which, as we have seen, there has been much extravagant speculation. Coal fields are usually formed in depressed situations or extended plains, which would be favorable either for the undisturbed growth of vegetation over the plane of their inclined bottoms, or for the accumulation of vegetable substances washed down from surrounding high lands; and these being inclosed in the accumulating deposits, would be well calculated to have caused the inception of subdivisional planes of affinitive action, to which carbonaceous forms in future times would affix themselves in formation of strata.

Though the forms and impressions of plants are abundant immediately above and below the coal seam, they will be but seldom or never found in the interior of such beds, for real coal strata contain no such forms, unless it may be to a very limited extent, except on their exterior surfaces, and on the ceilings or floors of sandstone or shales by which they are bounded. They would not be included in the interior of the coal beds themselves, for they are not vegetable accumulations as supposed, but have accumulated or converted the most of their constituent carbonaceous particles posterior to the time these vegetable impressions were imparted. And if the center of the incipient vegetable stratum or plane of affinitive parallel for carbonaceous accumulation contained at that time but the thickness of a single leaf, the center of such leaf might in some cases constitute the axle plane of affinitive action for the accumulation of the coal bed; and were observers particular in their inspection, they might at times discover the impress of the same leaf or plant upon the rocks forming both floor and ceiling of the same coal stratum, even though now separated by the whole thickness of that stratum, or many feet, for a single leaf may have been all in that particular continuation of a vegetable parallel, in which case its center would have continued the initiative parallel for the future accumulations of the carbonaceous bed. But while these coal beds must have acquired their thickness by the transformative accumulation of carbonaceous matter since the vegetable deposit which caused their inception, it must have been altogether different with the sandstones and shale beds therewith associated; for their constituent matter, and the vegetable forms found therein, having been contemporaneously deposited, it may be expected that fossil forms would be found interspersed anywhere in the mass, being washed together from the high lands and sloping hill sides, and deposited in commingled quantities in the inclosed coal basins, the least determined forms of this heterogeneous mixture the most readily affiliating with those in the carbonaceous bed.

How much these carbonaceous, bituminous, or other constituent molecules may have been facilitated in their formations and constructions of coal strata by the particular form of the fields and the constant percolation and transporting effect of the aqueous substance through the associate sandstone and shale beds along the parallel of the coal-forming planes, we do not now undertake to specify, but we may safely infer that it must have been very considerable in its effects on the formative processes. It will now be perceived that geologists and philosophers have taxed their inventive powers to little purpose, when attempting to account for the production and accumulation of the vegetable matter which they assume to have been compressed into existing coal strata, extending, in many instances, over hundreds and thousands of square miles. And in confirmation of this absurd assumption they have made microscopic inspection of thin plates of coal, which has strengthened their conviction of its vegetable origin, but unfortunately they have mistaken the mineral formation of coal for the structural formation of plants. Seeking to fortify a favorite theory, and finding the mineral texture of coal somewhat analogous to the vegetable texture of plants, they have erroneously assumed the two substances to have had one and the same origin. But as both substances were fabricated by the affinities of matter, a marked similitude of conformation is not proof of identity, for in following physical progression in its proper order, we find the effect of the affinitive relations to have been but slight modifications of the same general rule. By this rule we are enabled to deduce in the most simple and satisfactory manner the derivation and progressive formation of the earth's coal strata, without attributing them to vast accumulations of vegetable product at a period when her terrestrial flora first began to prevail on her surface, and contrary to every conceivable mode by which they could have been thus accumulated.

In many of the coal measures we find other interstratified beds, whose texture proclaims them to be of affinitive formation. These beds being not otherwise stratified than in the formation of their parallelisms with the rocks between which they hold their positions, it is usual to regard them as having had a different origin from their associate rocks. Having considered the coal beds and intermediate sandstones as having had an aqueous origin, these trappean rocks have been denominated igneous in contradistinction to them; and this has caused much useless controversy, there being so much difficulty in accounting for the regularity of the interstratifications among rocks of such opposite origins as the aqueous and igneous. All the theorizing respecting the possibilities by which their molten matter could have been projected into such complicated and compressed positions has totally failed to furnish satisfaction, and no wonder at such a failure when thus endeavoring to account for impossibilities or casualties that never could have occurred. From whence could the molten matter have come so mineralogically diversified, that the different kinds of the trap family of rocks should so often pass imperceptibly into each other, and often in the same series, or even in the same bed, dike, or vein? From the same source there could not have been ejected matter mineralogically different, so that on consolidation it would assume the various characteristics belonging to the trap family of rocks. And even if it could, how could the spaces have been prepared for its reception? How could the stratified beds have been so regularly rent open and separated for the admission of this intrusive mass in its molten state, and room made, without any corresponding enlargement of the penetrated beds? Or how could the molten matter have passed imperceptibly into stratified substance? Or how abutted up against such a rock in continuation of the same parallel? Or have intruded therein interstratified projections of its own matter without displacing the stratified matter which both its general substance and its seams now occupy? Or, if displaced, how is the total disappearance of the displaced matter accounted for? To what regions did it betake itself in giving room for many of these igneous intrusions? These are questions so totally unsusceptible of solution or answer, that they must at least militate much against, if they do not entirely disprove, the theory which assigns to such rocks an igneous origin. The seemingly altered conditions of the coal strata (which are often changed when in proximity with trap rocks when intersecting their beds) we consider far from proving their primary high temperature, for there are other causes not so far-fetched that will more consistently and conveniently account for the phenomena imputed to igneous action. And if the texture of coal beds or other strata were changed by this igneous intrusion in one case, why is it that it has not altered their texture in every case of intrusion?

Were the mineralogical character or lithological texture of the beds the only difference found in the strata when intersected by such walls of rocks, they might be supposed to have produced this change; but there are other phenomena therewith connected for which it can not possibly account.

How, for instance, could the molten matter at any degree of heat have changed the *quantity* as well as the quality of the strata? Coal beds of several feet in thickness are often changed to so many inches when in contact or proximity with the intersecting rock; and if the heat could have deprived the coal bed of its bitumen, still that could not have caused it to become so comparatively meager in thickness. How did this molten intruder dispose of the amount of primary matter taken from the bed? Or how make the sandstone or shale beds above and below expand till they occupied the vacated space?

If heat could have turned a small portion of such coal bed into coke, it could hardly have converted so large a portion into sandstone or shale to compensate for diminution, and to preserve the general depth of the series without any chasm.

Other stratified beds besides coal are found to be altered in many respects from their general condition, when in contiguity with intersecting rocks, without affording legitimate evidence in favor of the hypothesis by which the interposition of these rocks are sought to be accounted for, and which so signally fails in interpretating much of the phenomena for which it is introduced, besides making its own phenomenal characteristics a question.

Were physicists better acquainted with the very important fact of fire and affinitive action being one and the same thing, they would easily perceive how it was that affinitive action formed the world, including its rocks, from matter as well qualified as if effected by igneous fusion. We would suppose it perfectly sufficient for all purposes to say, that as the deposited matter that forms the stratified rocks could not have fallen in limestone, sand, coal, clay, or conglomerate, these must have been subsequently formed by its own constituent affinities, and with no necessity for fusion whatever.

Fusion can only be regarded as the reduction of the constituent molecules of a mass, from the restraints imposed by its solidity, by imparting a high state of excitement induced by affinitive action in the constituent condition of insensible substances. This high excitement renders the constituent molecules of sensible substances free to form more favorable associations; and the formative action among these molecules so promotes a continuance of the high excitement by which they are liberated, that others, as well as themselves, are set free.

Substances are only induced to this extraordinary degree of temperature that causes fusion by the effect of affinitive action in the formation of substances extraneous of themselves, and this high excitement can only be prolonged by a continuation of the formative process, because where that is suspended, the innate affections of the fluid being no longer disturbed will progressively restore the constituent molecules to their original quiescent solidity.

This high calorific excitement which can cause the fusion of a usually solid mass, being only induced by the combustion of sensible substances, or the affinitive action of its own matter, would seem to be the converse of formative action, for so far as we can see of combustion, it seems to be *destruction*, instead of *construction*, and in reality this destruction of sensible or solid substances is a resolving of their matter into insensible substances by a greater satisfaction of the affinities of this same matter, bringing it back to its more rudimental state, ready to be again erected into sensible substances when other circumstances are favorable. Nature always uses these insensible molecules for the manufacture of her sensible products. But the usual substantive formations could not have been effected under such affinitive excitement as could have caused the fusion of a usually solid mass. Fusion implies substances in previous solidity, otherwise what need for the fusion of matter always fluid?

It is difficult to conceive a scheme for the formation of a world more truly inconsistent than that which would call for a calorific excitement sufficient to preclude the possibility of all distinctive formation whatever, or that should have required rocks to be solidified in the interior of the earth in order to fuse and force them outward to form its surface-accessions of intrusive or overflowing rock.

There must have been a time when the matter of rocks was far differently conditioned from that of its present state, and it would be absurd to suppose their construction began only after the forms (of which they are fabricated) were furnished, for many of them are not even now affinitively solidified. The grains of sand, or particles of clay or lime or crystals, of which the respective rocks are aggregated, are each individually a more perfect formation than many of the respective masses of which they are the constituents. As these did not so fall, they must have been formed by the mutual affinitities of their own contiguous and constituent sphericles after the matter had been deposited in mass, from sources such as we have seen. The bodies contributing deposits to the earth could not have been in condition to consolidate matter into granules of any grade. We can conceive of the fall and filtration through atmosphere and ocean of molecules so condensed as to induce their subsidence and subsequent formation into crystals, or even so palpably condensed and confused that their forms in mixed mass would not transmit the rays of light, or construct crystals, but we can not conceive them already formed into the constituent materials of stratified rocks. We hold that the constituent forms of stratified beds were effected by the mutual affinities of their own matter after it had been received by our earth, and subject to all its conditions of pressure and affinitive action in the positions in which it is now found solidified into rock.

By this action we have accounted for the formation of crystals, which is the most perfect form of solidity, and by these same affinities we have the particles of limes, clays, sands, conglomerates, and coal, and by the effect of the same force we can account for all unexplained facts found in geological structure, whether it be in the construction of crystalline or granular constituents, or their consolidation into rocks.

The molecules of matter aggregated in mass, being a mixture of forms affinitively different, time and their united affections could alone separate and associate the specific sorts, so as to present their present conditions, subdivided in beds of assimilated kinds, or in intersecting dikes or veins, or inclosed masses of various mineralogical character, imperceptibly blending into, or abutting against, each other, or penetrating each other in parallel seams, and terminating at certain distances.

When the special affinities were forming a coal bed, intermediate of other rocks, by the carbonaceous assimilation of material forms, and at the same time intersecting it by a dike of a different order of construction, the affinitive conditions in proximity with the dike, acting beyond the immediate sphere of their own formative plane, would often necessarily have a modifying effect on each other, so that their mineral texture would be at times somewhat changed, both in the character and form of the rock, the more affinitive being less changed than the feebler. This would be the regular process of nature where neither fire nor fusion could have had any agency, for the affinities could not be expected to separate in such proximity without having an effect upon each other's formative action.

We often find that the strata on one side of these divisional dikes are cast down to the depth of many yards below the parallel of what is understood to be the same continuation on the other side of the intersecting wall. This is particularly noticeable in many of the coal fields, causing faults in the working out of the beds, and has been the subject of much speculation, not only respecting the force which dislocated the rocks, but separated them for the insertion of these partition walls, even to the extent of their whole thicknesses, which is often very considerable, and upheaving or depressing the whole series on one side of the same dike to depths not penetrated or known. Such dikes are frequently found passing through the coal measures in different directions to each other, and with no specific inclination or relation to the plane of the deposited beds, except as oftentimes when passing in beds of intermediate parallelism. These dikes and beds are often of very different complexion, even when at no great distances from each other, as if they were of very different materials, which involves the question of from whence did these differentialities proceed so as to have caused these several kinds?

All the difficulties in which the whole subject is involved are of a kindred character with those besetting physical theorists in general, for the premises of their argument being erroneous, the inferences therefrom will be equally so. That these vast systems of rocks subdivided by narrow partition walls should have been (in relation to each other) either upheaved or depressed involves the consideration of subjects that can have no possible place in nature. In the first case there would be required a force far more powerful than the ponderosity of the whole uplifted platform, for besides raising the whole sectional plane of incumbent rocks from the foci of its power (however deep seated in the earth it may have been) against its own gravity, it must likewise have dislocated them throughout their whole depths, for if they were upraised, it must have been from some previous formation constituting the foundation of such upheaval, and by some upheaving substance having permanent powers, otherwise their own gravity would have again depressed them to their previous position; but that has not been done to at least the upraised portion of the district thus assumed to have been disturbed, for it seems to remain permanently elevated above the other. Now what could have been the character of this upheaving substance, or what could have caused its action? is the next inquiry, or from whence came it, or how was it subsequently disposed of? How got it below the upheaved mass so as to rend the incumbent rocks to unknown depths, and raise them from their foundations by sections, and that, too, without disturbing any thing but the upheaved areas?

These considerations or questionings so importunately present themselves *à priori* of upheavals, that it would surely be well to have them first investigated so as to be distinctly understood and established before a proposition so opposed to all the recognized powers of nature and experience should be so generally entertained, persisted in, and imposed upon the world's credulity. If there are no laws or forces in nature by which such upheavals could have been effected, then the whole hypothesis is without foundation in fact, which is the conclusion to which our deductions determine.

If there is not a possibility in nature by which the rocks on one side of a partition wall could have been upheaved above the stratified beds of the same continuation on the other side, neither could it have been in nature that the rocks could have been by that much cast down; they could not have been depressed into their own solidity or forced down beyond their own foundation-rocks, while those from which they were dislocated maintained their primary position.

Philosophers have failed to furnish the world with the most distant conception of such internal condition as will afford to themselves or others the data from which to deduce the forces from which so much is so constantly called for. So far as physical inquirers have furnished the evidence, all is mere unfounded conjecture, expressed in unmeaning phrases, and opposed to every well-established principle of physical law.

If geologists would only permit themselves to be undeceived, they would find the facts on which they found their hypotheses testifying to very different things; for let the stratified beds on opposite sides of the same dike be consulted and rigorously interrogated, and it will be found they are not identically the same nor never could have been. The strata on one side of the partition wall will always be found to disagree in some of their peculiarities—in their thicknesses, in their textures, or in their mineralogical developments—with those on the opposite side of the same wall, and their corresponding similitudes will be found insufficient to justify the opinion that they acquired their characteristics in the same continuous plane of parallelism. But these stratified beds, although not having attained their characteristic developments as continuations of the same plane, may in many, if not all cases, have been incipiently continuous of the same subdivisional parallelisms, before the affinitive construction and condensation of their own constituent ingredients caused the formative systems to separate intersectingly for the insinuation of such molecular and differently characterized matter as now constitutes the dikes. Thus we see how these sectional separations were formed in the same system of rocks, whether regarded as separated by dikes or veins, and although the primitive continuations of affinitive parallelism of these beds were (in consequence of these intersecting dikes) at times discontinued, yet such must have been the cause of a constant relation which neither time nor circumstance could wholly obliterate, for each section would continue to retain some portion of each feature of the rudimental formation where it was continuous; but being subject to great modification through all subsequent time, in consequence of the difference of affinitive action in its formative character on either side of the wall of separation, they might not have continued in all cases equally alike. We have found that both limestone and coal beds have accumulated much of their matter, and expanded in thickness since their affinitive planes were first induced, and it may have been the same, and no doubt was so, with other rocks.

We have observed the textural and mineralogical passages of stratified beds into each other in the same continuation, together with the progressive thinning or ultimate termination of some, and the continued increase and thickening up of others in the same (but inverted) ratio, and all this at times within very inconsiderable distances, so that evidence is afforded of the formative effectivity of a deposited mass being easily changed; so that when a system of strata becomes separated by an intervening dike, thus cutting off all interchange of sympathy between the affinities of the several sides, it might be expected the effect of their action would be different on the different sides of the dike, the aggregate thickness of the whole being more on one side than the other, which unfortunately has been mistaken for a general heaving up of the whole sectional series, when in reality it was only an affinitive thickening up of the beds on one side more than the other.

These observations respecting dislocating dikes, though generally just, are not in all cases in every respect applicable, there being often cases where the strata on the several sides of a divisional dike never were a continuation of the same undivided plane; for the matter on the several sides of many a longitudinal axis of what is usually called upheaval, may have been so affinitively different as to induce subdivisional planes of parallelism of very dissimilar character, so as hardly to correspond with each other in any respect, in which case the formative forces of the intermediate matter which forms the dike must have been more or less modified by the affinities on each side of itself; therefore the constructive character of this intervening matter can be in accordance with neither, but must necessarily be such as its own affinities could most readily effect under the influence of the modifying forces on each side of itself; and from these intervening walls of unassimilating character the formations on each side would also necessarily shrink (as a consequence of their longitudinal contraction), thereby widening the intersecting wall in the manner already considered.

Thus these extensive dikes constituting the axle planes of primary deposits may be regarded as being of an originally different character; that is, originated in a different manner from those usually traversing coal fields. Those in the coal fields being altogether the effects of affinitive condensations of the deposited mass, causing a contraction and transverse separation of this system of beds, and the occupancy of the enlarging apertures by molecular particles constructing different conditions from the intersected rocks on either side. These rocks may at times have reciprocally altered each other's condition by blending, to less or more extent, the formative processes, so that the rocks in contiguity might seem to have been altered, while the dikes occupying the axle planes of primary elevations have been induced intermediately of two distinct parallelisms of affinitive action, in the formation of the separated systems of strata, that never could have been continuous, the constituent affinities of the central mass assimilating with neither, but by its own forces effecting its own distinguishing characteristics of texture that is so usually taken to be of an igneous origin.

These vertical and intervening masses are usually of very considerable width, and more persistent in their continuations than the dikes in the coal measures, which seldom extend beyond, and are much more like veins in rocks intersectingly separated by contraction.

To these intersecting walls of rock (whether perpendicular or inclined at any angle to the strata they are traversing), the contiguous or abutting edges of the strata will always be found conformably fitting close up against the intersecting dyke, an evidence that they could in no instance by their irruptions have thrust the strata up at any angle differing from their primary positions; for had the coal and intermediate strata been elevated, as they sometimes seem to be, their tilted edges could not have conformed to the plane of the wall. The intersecting rocks of coal fields, and all more primary systems of stratified beds, at times divide themselves by certain angles into two or more separating walls, in which case, when the angles are most acute, the intermediate matter of the strata will be different oftentimes from the rocks on the external side of either wall; because, being thus cut off, it would be unable to resolve itself into a similar order of affinitive parallelisms with the external beds, and would affinitively form itself into masses of more or less seeming confusion, being affected by its own affinities and those of the intersecting dikes.

In thus contemplating the course of nature in her formation of coal fields, we find that though primitive vegetation often originated the relative positions of the coal seams, it does not follow that vegetable matter was accumulated and heaped up till it formed the whole mass of the present coal beds. As we have already described how these measures were formed, we spare the reader the repetition.

The deposits next in succession to the coal measures mark an extraordinary and very important epoch in geological progression, for they indicate the termination of an immensely long period during which but comparatively very little material accessions were made to the earth, and during which time the transformation of the waters of the ocean into the rocks of the earth exceeded in quantity the amount received by the fall of cometic bodies, and its formation producing a progressive but oscillating recession of these waters to their lowest level, and that even below where that level is at the present time.

This was not only the termination of the formation of a regular series of coal measures, but was likewise the turning point of the general and long subsidence of the sea. The addition of aqueous and other matter from the coalescence of meteoric bodies, whose solid constituents form the new red sandstone groups and other secondary deposits, now began to cause an increase and considerable elevation of the waters in a progressively increasing scale, not wholly because of their absorption and appropriation by the consolidating rocks becoming much less extensive and its own formation more considerable, but because of the filling up of the bed of the ocean with these solid accessions being so much in addition. All this is a development of facts to which the geological records of nature bear conclusive testimony; for we find every phenomenal fact following as a necessary consequence of the causations originating in the same certain system of dynamical law from which we have already deduced so much; and surely no system of physics can have greater claims to perfection than this all-sufficient method by which we are able to deduce the phenomenal facts, not only of geology, but of every department of general physics. There is not a phenomenal fact in nature for which these affinities or formative forces are not fully answerable, at least so far as we have yet pursued their effects, and their dynamical effectivity only receives further confirmation when we consider the conglomerates, sandstones, breccias, and saliferous rocks of the red sandstone series, together with limes, clays, marls, and crustaceous rocks of the succeeding formations, all so unlike what could have been acquired from the broken-down fragmentary matter of former rocks. What else in nature other than the constituent affinities of matter could have effected the phenomenal conditions which are manifested in these rocks which are so unlike those which preceded them, from which it is assumed they have been derived?

Physicists have certainly failed either to solve these important problems in any thing like a satisfactory manner, or to furnish data by which a solution can be obtained; for it is certainly not to be found in the mechanical processes or igneous fusions and convulsive irruptions which they have adopted as their method of accounting for the origin, formation, and position of the several kinds of rock.

When we contemplate the manner in which all the differently constructed rocks of the earth graduate into each other, we shall find no theoretical system of physics that has been yet entertained which can by any possibility be made in any thing like a satisfactory manner to account for this passage of rock-forming matter, particularly that which supposes them to have originated in the destruction, transportation, and deposit of the ingredients of previously existing rocks, or the irruption of such as were in a state of igneous fusion; because that would imply no real origination to their matter at all, but that there always had been rocks ready for destruction or fusion, so that such rock-making matter might be thus furnished; and it would furthermore signify that there had been currents, counter-currents, cross and complex, together with fusions, convulsions, casualties, and confusions altogether inconsistent with any possibility of physical order in nature or comprehensibility in sense. Rocks and the constituent properties of rocks must unquestionably have originated at some period of our earth's progress, and from some source; their materials could not have been always thus forming and re-forming without any origin to themselves.

These constituent particles of the existing rocks are themselves as much of structural formation as any other substantive mass, and are no more to be regarded as a first principle or primary thing than is the rock of which they form a part. Therefore the consideration is, what was the condition of the materials of such rocks before, or at the time of their deposition? If they were in detached particles, detrital constituents, or debris of former rocks, what must have been the conditions of these pre-existing rocks, or where could they have been situated? Are we to understand that they, too, originated in former rocks? and if so, how far back must we go to find what was really the origin of this formative action, when matter was in such a condition as did not need to be thus melted down by fire or ground down by the friction of water? The action of either signifies a structural condition on which they could have been thus effective, and from which such matter was by these processes reduced. There certainly must have been a time in matter's formative progress when it could have required for its reduction no such active processes, it not having yet assumed conditions from which it required to be reduced the better to fit it for a rock-forming substance. The effect of high calorific action is to disturb the infinitesimal attachments by which the solidity of existing substances is assumed, so that the constituent molecules may be again at liberty in affinities in other relations, and thereby form new substances. When this could only operate in its existing effect in substances already formed, or it could not have so furnished the matter from which it is said the present rocks have been created; and even suppose it had, there is as much difficulty in accounting for its subsequent solidification into existing conditions as there is in accounting for its progressive erection into the most primary rock; the affinities of matter would require to have been effective in either case, and we can not see why most of the existing rocks should not be considered as being in their most original state. The constituent ingredients of rocks, even to their least recognizable particles, being as much of a constructive character as the rocks themselves, we can not conceive why, as a general rule, they might not be admitted to have been constructed together out of such conditions of matter as was deposited, for otherwise where is the conceivable locality of the more primitive formations from which the matter for all the existing rocks that are now subject to observation could have been eroded or erupted? Geologists, by what we must infer from their own accounts, have totally failed, so far, to find a rock that has not been produced either by the originative effect of the washings of water or meltings by fire. It would certainly seem from all this as if Providence had taken much pains to hide from their unholy scrutiny the primitive process of rock-making, so that they should have nothing in that line but such as was at second hand. When they extend their researches to the bottom of the sea they find but the fragmentary matter of former rocks. If they penetrate deep down to the foundation-granite they find in it what had been the fused matter of former conditions. If they search the stratified structures of the earth they still find but the remnants of a former world in the broken-down fragments of its rocks, and they nowhere inform us how far it would be required that the earth should be penetrated before we could find a rock as rocks were when they were first formed. Every granitic mass, say they, has been upheaved while in a molten state from its primary depths, tilting up all the stratified rocks incumbent thereon, but they do not inform us from what condition of solidity all this granitic matter was fused, or what subterranean force could have upheld all this fused matter until it crystallized into solidity.

This system of geological dynamics by which it is undertaken to account for the existing condition of the earth's rocks, we find involving such absurdity as makes it much.more difficult to realize that the wise ones of the earth can entertain such notions than it does that of how the rocks were really formed, for, in the system we are pursuing, we have to encounter no forced constructions nor overstrained inferences; all flows on freely and harmoniously with all, in giving phenomenal expression to creative thought.

We have already seen that the velocity of the fall of meteoric or cometic bodies through our atmosphere and ocean would dissipate any previously acquired solidity there may have been in the matter of such descending bodies, so that their most solid matter could only descend to the sea-bottom as the most impalpable powder, by which it will be perceived that the constituent ingredients of the rocks as thus received could not have been as they now are, but must have acquired their present characteristics after they were deposited in the situations they now occupy.

The molecular condition of the matter of many of these descending and coalescing bodies may have been such anterior to reception as to have had much to do in determining the form ultimately taken by the constituent particles or granules of the consolidated rocks. Whether it should be crystals, trappean rocks, limes, clays, sands, coal, conglomerate, concretions, or salt rocks, all these varieties are altogether inexplicable on any other principle than by the force and fecundity of their own constituent affinities constantly operating. And to this the metallic substances associated with other forms of matter in the construction of veins traversing the rocks of almost every age furnish their testimony. What else than the affinities of the matter itself could have constructed these intersecting veins of metals, when no vestige of metallic substances is found in the rocks traversed or in the granite from which they are assumed to have been derived? Many of the native metals are found so associated with quartz rock and with each other in the same vein as to show that these metals and the associate matters must have crystallized cotemporaneously, a condition fusion could not have effected under any circumstances, fusion being in all cases antagonistical to crystallization, or formation of any sensible kind being the means employed for its reduction when the constituent matter is required for other purposes; therefore, when slowly cooling, in order to form crystals again, the different degrees of temperature required for the different crystallizing substances would prevent such associations as we now find of the native metals in one vein, for this would have precluded their crystallization in one associate mass.

And the same for segregation if high heat was the cause, for crystals forming under the highest temperature could not have been associated in suspension with substances that could crystallize only at a low temperature. In contemplating the association of substances in the metalliferous veins, it certainly does seem that the molecules penetrating such apertures must have been affinitively ready for this form of structure. The relative energy of each order of formations being equal to the metamorphoses of such molecules as were most readily convertible into its own structure, the associate and cotemporaneously formed substances in the same vein must be in relative quantity proportional to the disposition of the admitted molecules for forming those particular substances, and it really would seem as if the matter of quartz had been almost as ready to assimilate in the formatian of any of the metals as it was for its own substance, for we find it so readily associating with almost all of them as if it might as well have been of one substance as of the other. All forms are but so many sensible expressions of the formative effectivity of its own affinities under the circumstances in which they made their election, the formative affinities being as the muscles which give physical expression to nature's will, so that we need feel no wonder at finding forms of even sensible matter whose sensible integrity can not be disturbed by finite powers. The conservations and casualties in nature's phenomena must depend on the proper graduation of integrity in the forces of her material forms; and as much on the comparatively indestructible as on the most evanescent of her productions; but while all forms are necessarilv finite, none can have a perpetual immunity from transmutative action, when the conditions and circumstances of their formations are changed.

Therefore the chemical elements, or those constituting metals or minerals, are to be regarded as induced conditions, and no more the simple properties of matter than any other compound form it could have been induced to assume. Material forms are all fabricated things, being but the sensible expression of Infinite Thought, and as projected from thence into the sphere of finite perception by means and measures proceeding from the affinitive attachment of energy to atoms. This attachment constituting the first physical act of Infinity abrogated the abstract simplicity of both the atoms and the attaching energy, so that all beyond could only be by combinations and conformations consequent from the effective action of these now compound atoms, until they ultimately resolved themselves into the rocks of the earth, and all other substantive conditions of sensible character.

But the constituents of these rocks could not have so resolved themselves but for the conditions imposed by the aggregated energy of the earth's mass; and as that could have had no great effect upon the matter before it was deposited, the deposits could have been but little characterized in accordance with present conditions, particularly with the coarser forms or ingredients that compose the present rocks.

Thus all minerals composing the crust of the earth are to be regarded as conditional substances of secondary character, and their more particular abundance, as we approach the surface, conclusively proves that conditional circumstances were only then favorable for their formations; and every constituent particle of such substances may likewise be reckoned in the same category, they being aggregates of infinitesimal forms, and having acquired their structural characteristics in accordance with the conditions under which their formations were effected. These conditions were no doubt as effective in the fabrication of the constituent ingredients of rocks as in any thing else. We see no more necessity for forming the rocks by ingredients manufactured in some remote and entirely unknown part of the earth, which even geological research has failed to find, than we do for any other formations, and more particularly as they would require forces for their transportation effective at different times and seasons, forces that would fetch the differently manufactured materials in the order of their superposition and succession so as to form the respective strata in the several geological systems. Such forces must have acted by rule, or there could not have been such regularity in the alternating order of such stratified systems, and this rule would certainly have required a regulator.

Chapter Fifteen.

Currents of the Ocean, how Formed—Disintegration of Rocks—Inconsistencies of Theories—Cause of Motion in the Waters—Gulf Stream—Mediterranean Sea—Differences of Elevation between Equatorial and Polar Suns—Extinction of Animal Races—Reproduction—Comparison between Periods—Recession of the Ocean.

GEOLOGISTS conceive that this transporting power consisted in the efficiency of aqueous currents, because water could so readily, when in rapid motion, take up or urge forward these materials or let them fall or rest when it ceased to run.

Now we should be very much pleased to know by what rule these currents were regulated, that they could so conveniently have brought this or that form of matter forward in alternating progression, such as now form these stratified rocks. There could not have been such currents on land, for there were not elevations or countries from which rivers could have run when most of the rocks were placed in their present position, for all seems then to have been sea, and currents in the ocean capable of bringing so many different conditions of matter thus far and no farther, and to have so alternated them, seems more unlikely still. We have yet to learn from the wise ones what could have induced such a multiplicity of adverse currents as would have been thus required in an ocean equally full. We have always supposed inequality, either in quantity, condition, or temperature, was the cause of currents. And we can not possibly conceive into what the rushing waters could have run while all was equally occupied; and even if there could have been currents, how could they so readily and suddenly have alternated the matter with whose transportation they were charged? Or how have been so differently effective over such circumscribed areas, as the rocks of the several systems would signify, for they must have crossed and recrossed in every conceivable direction with this kind of matter and with that to have effected the deposit of the different kinds of which the rocks in the same region of country are formed.

Currents in the present ocean there unquestionably are, but currents can only be induced in an ocean by a difference of temperature affecting its waters, and they would be general and uniform, on the surface of a uniform sea from the equator to the poles, with an under current in an opposite direction. A disturbance of this uniformity could only be effected by the formation of lands or a very considerable shallowing of some parts of the ocean. Geologists will do well to remark that such is the principal and almost sole cause of all the oceanic currents of the present times, equatorial heat expanding equatorial waters; but in primitive oceans, when lands were less prevalent and temperature more uniform, there could have been little cause for currents, and at least of such local character as could have procured and transported the matter of rocks in their alternating kinds, as is the case in the several stratified systems of no very persistent continuance.

Should there still exist any skepticism with respect to the physical affinities having affected the whole fabrication of the earth's superstructure in all its phenomenal phases, and particularly in the geological field of its labors, there are still further proofs to be found in the formations that follow those we have already considered.

The red sandstone formations, or the series next succeeding the coal measures, are almost exclusively of that character to which geologists assign an aqueous origin; which, so far as we are able to understand their theoretical systems, signifies, as we have already seen, that by the erosive and mechanical effect of the waters of the ocean, and of rivers upon the rocks of the earth, these rocks have been so torn up and disintegrated as to have furnished sufficient matter for the whole mass deposited after the carboniferous epoch; at least the rocks that are assumed to have had an igneous origin do not so much prevail.

Those must have been wonderful rocks that could have thus furnished this immense mass of matter constituting no inconsiderable part of the world; and wonderful, in a still more extraordinary degree, the activity of the waters of an ocean so equally full as to have had nowhere to flow, and yet could have broken up, worn down, and transported from so many different localities all the different kinds of this matter, in its multifarious shades of character, to their relative positions, embracing the several sorts of sandstones, conglomerates, clays, limes, marbles, marls, metals, salt rocks, cretaceous formations, and concretionary masses; alternating, graduating, and grouping together in endless intermixtures and modes of association, besides the involvement of masses of differently formed matter in each other's midst, without any visible way by which such involved substances could have been intruded. Surely any system that calls for, or involves such an order of things as this, at least seems altogether irreconcilable with reason, its contemplation a waste of time, and its promulgation an imposition upon credulity, without its advocates could prove the expediency or necessity (agreeable to the known rules of nature) of the dissolution and reproduction in a given time of the rocks of the earth, as it is with the trees of the forest; and even then the circumstances would be altogether inconceivable of from whence their material or from what their conditional character.

We are altogether at a loss to conceive why it should be imagined that all the rocks are reproductions, even including the very coal beds, in so far as their matter is assumed to have been derived from the vegetable products of the earth in some way transported to their present positions. It would be in some measure satisfactory were the advocates of this system to signify when it was the most probable that this process of manufacturing new rocks out of the old ones began; for so far as they enlighten us on this subject, we are left to infer to it such a perpetuity as abrogates all idea of any ultimate beginning whatever, when surely this can not be what they mean.

We willingly admit all the effect that can be legitimately claimed for the eroding processes upon the rocks, through the countless ages it has been in operation, and likewise the igneous outbursts consequent from volcanic action, but that must be a small matter when the whole depths of the stratified rocks are under consideration. We should suppose it to be very evident that any system of generalization involving such a concatenation of absurdities as are comprehended in this hypothesis, must be very far from being the true system comprehending the philosophy of physics; for while the science of facts and the science of physics must be considered as perfectly parallel principles, this can have but little claim to our regard either as the rule of nature or the regulator of inquiry.

But where, in all the theoretical propositions of physicists, do we find a system advanced that can by any possibility be pursued in all this harmony of parallelism? certainly there is little like it between the geological facts and the causes said to produce them, so far as we have yet progressed with the rocks, and we see but little prospect of any better success with those that are to follow; for when we contemplate the immense masses of conglomerate rocks (as forming the foundation of the red sandstone series, as alternating with and graduating into rocks of every grade and texture, and all these passages often in the same sections), and remember that according to the prevalent theory all this matter is fragmentary, we are again obliged to ask from whence could have come all these diversified ingredients, or from what substances were eroded the cements by which this fragmentary matter was again consolidated into rocks? And from whence came the coloring matter by which all these particles of sand and pebbles, of quartz or other rocks, were so regularly surrounded. The wide dissemination of this substance (at this particular epoch), whether peroxide of iron or any other preparation of that substance, is certainly a circumstance requiring explanation.

And from whence the immense blocks of quartziferous porphyries and other masses of every size and character that are so often included in sandstone and conglomerate beds? Or by what process could even the trappean rocks have been at times so blended with conglomerate that lines of distinction can not readily be drawn between them, and how, in other instances, have conglomerate pebbles become cemented by a sort of semi-trappean paste? Or how came the grains of transported sands to be cemented at all?

These are a series of problems that can only be solved by a system of causes parallel to their case. Will that be found in the mechanical effect or transporting power of the waters of the ocean, to which it is theoretically attributed? Let us for a moment look at what the promulgators of this hypothesis call upon the waters of the ocean to do, or, rather, call upon us to credit, and then see how far they could have responded to their call. By this mechanical system the waters are required to tear up, abrade, or erode previously existing rocks, and transport and deposit their matter in sufficient quantities to make all the stratified rocks of the earth. The prevalence of conglomerate rocks, the character and kind of their fragmentary matter is supposed to indicate powerful currents and great violence of action in the degradation and drifting forward the matter of different pre-existing rocks. The presence of large blocks of differently constructed rocks imbedded in conglomerate and in sandstones are likewise attributed to such currents as could have borne them from their parent beds to their present positions. Strong and strange currents, we should say, they must have been, that could have transported these immense masses, and the fine matter in which they are imbedded, and have let them fall together. We should suppose the currents strong enough to transport rocks that were tons in weight would carry the fine sands far beyond where it had let them fall.

The alternations of conglomerates with sandstone and other rocks, and their passages into each other, or into different conditions of structure in continuation of the same sections, is supposed to indicate that the velocity of currents must have varied very considerably in the intermediate neighborhood, as well as the direction; and it is further inferred that whatever may have been the force of these constantly varying currents, they must have had their source in as many ever-changing localities.

Thus it is phenomenal facts are tortured to give testimony in favor of either aqueous or igneous action, these being the only two forces to which the material derivation and formation of rocks are assumed to be referable.

If a conglomerate is the subject of interrogation, it must bear testimony to its constituents (however multifarious in kind or character) having been torn by the action of water or some other cause from their parent rocks; if the materials are largely developed, they must testify to the velocity and extent of the current having been proportionally great, and the degradating process violent. If the ingredients graduate into finer-textured rocks in continuation of the same parallel, there must have been a corresponding graduation in the currents; or if the rocks with which they alternate are fine-grained, they must testify to a more tranquil current in the transportation of their materials, and a less violent action in procuring them. If large blocks of differently characterized matter are inclosed in any of these beds, they must tell of violence and strength of the waters by which they were torn from their parent rocks and transported to their present positions with a current proportioned to their own ponderosity, even in total disregard of the circumstance that such a current as could have transported them must have urged the finer matter in which they are imbedded much farther on. The materials of the several beds of a series being differently conditioned from each other, or graduating into such as are different, must testify of as many currents changing in velocity and direction. Fine-grained textures and laminations parallel to the general plane of strata must tell of deposits in tranquil seas and slow erosion from the mother rock, while oblique, curved, and contorted laminations give evidence of cross and conflicting currents varying in direction and velocity.

Thus we perceive, by this most extraordinary torturing of evidence, the stratified rocks are made to testify to their origin as having been effected by a very efficient system of oceanic currents of every character, in every possible direction, alternating, changing, crossing and conflicting in every conceivable and inconceivable manner, and being charged with the procuration, transportation, and deposition of every form of fragmentary matter found in what are called the secondary rocks.

Now, while we have all this, as we are informed, from the effect of these parallel and lateral currents in the ocean, it would seem as though there must have been at times vertical motion of no inconsiderable extent; for while we have the conglomerate rocks, with their eroded fragmentary constituents, as the effect of horizontal action, we have at the same time the breccian beds, with their angular fragmentary constituents, which could never have been transported at all; and agreeable to the same rule of reasoning, as respects the fragmentary rocks, they must have been effected by vertical action in the waters, or by some other means broken up.

At times massive beds of rocks are found with a solid and unbroken base, gradually separating into very massive breccian blocks, often of tons weight, and these graduating upward (by diminishing fragments of the same material) into well-characterized breccian beds, and these again passing in rounded or angular forms, in association with other fragmentary substances, into a regular conglomerate.

Now it will certainly follow that if the fragmenatary matter of rocks in general has been transported, rounded, and spread out by the horizontal action of the waters, the fragmentary matter of the breccian beds must have been detached by great violence and thrown upward by vertical commotion of the waters; and if we desire to know how the associate matter in these breccian conglomerates was so very ready to afford their quantum, lateral currents will again be urged as a cause, they deeming the ocean to be always ready charged with the requisite matter, and willing to let it fall when and in such quantities as required.

These are but some of the extraordinary things of this extraordinary system, for besides the many wonders attributed to its action already noticed, it is still further assumed to have furnished the whole quantity of succeeding rocks consisting in part of the vareigated marls, clays, carbonates of lime, carbonates of magnesia, variegated sands, cretaceous deposits, and calcareous rocks in all shades of character, in all alternations, passages, and superpositions, including immense masses of gypsum and rock salt, and other concrete substances.

Now, in the name of all that is natural, how is all this to be reconciled with reason? Certainly no one will contend that any of these massive deposits were produced in an hour, the immediate effect of any disturbing force however violent it may have been.

Therefore the currents bringing them forward must have been prolonged, and to have been prolonged in an ocean, they must have been in a continuous circuit; and for currents to have been in a continuous circuit would demand continuous cause of motion, and that could not have been in the waters themselves, for they are utterly incapable of propagating motion *per se*.

Water being almost incompressible, could not have been forced back on itself so as to oscillate back and forward for a time over certain areas, in virtue of its own elasticity; that they might have been thrown upward is possible, because, in a vertical direction, resistance could be overcome with force proportional to their incumbent ponderosity; but they could not be projected out into a current horizontally unless a circular motion could have been induced, so that the waters in advance would constantly make way for those that were to follow. If such a current were possible, the cause that could give rise to it would have to continue as long as the current itself; for were it but an impulsive force, the motion of the waters would cease with the impulsion, because of their own gravity and inelasticity, except in so far as waves might be propagated upward and outward upon the surface, which might, for a brief period, be excited to undulous action, radiating from the center of surface-force within a comparatively inconsiderable circumference; but let this surface-action be what it will, there is still no possibility by which the disturbing force affecting such action could produce currents in the depths of the seas. No disturbing force from above could effect it into currents; such could only be agitated by the action of its bed; therefore immediately this foundation-force ceased to operate, the waters would be restored to rest by the pressure of their own weight. The fabricators of the earth's rocks, by the action of oceanic currents, will find no refuge in the further supposition that the foundation forces may have been of long continuance, *i. e.*, of prolonged action, and by that means have lengthened out the time of agitation, for, opposed to this, there would not only be the ponderosity of the waters of the ocean, but there would be the gravity of the heaving earth and the solidity of the rocks to overcome, by any such force as could effect a prolonged commotion of the waters by this means.

The very idea of such a force thus affecting nature in the converse order of her laws of action is certainly too palpably preposterous to be for a moment seriously entertained. Nor can we conceive from what principle in nature theoretical geologists can deduce the currents they are so constantly calling to their aid, as causes of phenomenal development. Will they lay down the hydraulic rules or hydrostatic inferences by which the primitive oceans were thus pregnant (we might almost say to prodigality) with currents of every characteristic grade, for we confess to be altogether ignorant of any such hydraulic laws as could have generated and governed the conduct of these-matter-originating and rock-making currents of the primitive seas, as geologists describe them.

We do know that the hydrostatic pressure of the present seas would at once resolve them into rest on the cessation of extraneous action; for, as we before observed, they being in perfect molecular equipoise with respect to their own force, affinitive action could have no motion *per se.* We likewise know that the atmospheric pressure on the waters must cause some agitation on the surface by frictional pressure when in motion, but not sufficient to cause currents in the depths of the sea strong enough to disturb, transport, and urge forward solid matter, such as it is said to have done over its bed. We likewise know that the moon and the sun affect the waters of the ocean, causing successive tidal waves to flow; but geologists attribute little or nothing to the efficiency of these motions, nor need they, for they could not produce currents such as are contemplated for the production of the rocks. These are, however, the only external forces applicable (in the present age of the world in any thing like order) to the oceans that could affect agitations or motions of the waters, but by no means sufficient to produce powerful currents. There is but one more way (other than the effect of these direct forces) by which the waters of the ocean could be permanently disturbed from the quiescence induced by their constant tendency to equilibrium by their own molecular affinities and made to flow in currents, and that is by a constant infraction of the perfect equipoise of its own affinitive condition; and this is fully accomplished in the successive expansions of its molecular constituents because of the more direct calorific action of the sun, thereby causing enlargements and consequent expansions of the waters more immediately under its influence, whose maximum effect will be found at the equator, and its minimum at the poles. This elevation of equatorial waters (from their own gravity) would necessarily flow north and south from this elevation, a compensation in undercurrents being in precisely the reverse direction, thus forming a continuous current which, by causes hereafter to be mentioned, might be more or less condensed and turned aside in their passages; still all oceanic currents, agreeable to the existing order of things, must necessarily originate in this general source, and be of such directional tendency.

Assuming that the earth were equally covered with water, there would be but only two oceanic currents in the two hemispheres, flowing from the equatorial region north and south on the surface, and returning underneath in an opposite direction. All the currents of the present seas are but modified effects of this great fundamental principle of aqueous expansion and the cause of all constant currents. The earth not being equally covered by water causes all the modifications of the currents that now prevail. By consulting a good map of the world we may readily find, by the configuration of the lands or shallow seas, where either of these two general currents of the ocean has been thereby ruled into its present direction. At the tropics, the currents being diffuse are but little noticed; but when condensed by obstructions to their free passage by prominent lands, they flow with considerable velocity, of which the Gulf Stream, on the south-eastern coast of North America, furnishes a conspicuous example.

This current is caused by the molecular constituents of the waters of the Caribbean Sea and the Mexican Gulf being heated and expanded by the action of the tropical sun, till this enlargement and lessened specific gravity causes them to be elevated by the colder and more condensed waters flowing by under-current *into* the same seas, and necessarily imparting to them a tendency to flow off in the most depressed direction. But this general elevation above the Northern Ocean not finding a free and direct passage, would pursue the most ready direction that the bounding lands and the required depth of the sea would admit; and hence it is that we have all these heated waters accumulated by this deflection of their general course into an oceanic river constantly fed, and expanding in its northern progression by the addition of all the heated waters descending from this parallel of equatorial elevation. As this stream progresses to a higher latitude, it gradually becomes more and more expanded as the more rarefied waters crowd down upon it from the equator, together with its own diminishing force from having progressively radiated its own heat; and thus the stream is made to expose more and more surface for this radiation, so that by the time it meets an ocean with a free exposure to the north, it commingles with and measurably loses itself therein. This great oceanic river, by the reduction of its temperature and expansion of its waters, becomes, at the Banks of Newfoundland, so slow in its motion as to let fall, or no longer to urge onward, the matter with which it may have been charged, and thus forms a bar by which it is banking itself out from a further progress in the direction to which its tendencies would otherwise lead.

In consequence of this formation of sea and shore, we find the reason of one of the greatest and most persistent currents ever induced in the ocean, and find likewise it has produced a large amount of deposit; but the Banks of Newfoundland sink into utter insignificance when compared with the mighty systems of associate rocks which geologists ascribe to oceanic currents. And whatever they may suppose to be the effect of this great Gulf Stream, they will hardly infer that it, too, is alternating its deposits in the usual manner of geological systems.

The strong current setting into the Mediterranean Sea, and flowing out in under-currents, is another illustration of what expanded and heaped-up waters will do in finding a passage into a large exposure where the lower rate of atmospheric temperature, by extracting their heat, reduces their bulk and consequent elevation by their condensation. This constant reduction of the relative elevation of surface perpetuating the declination of level by which waters are made to flow, their tendency must be as constantly into this sea, while the waters of reduced temperature must as constantly flow out by under-currents, by this means preserving the rule of circularity so absolutely essential in all oceanic currents, which must necessarily be compensatory. This expansion of water by higher temperature in the tropical ocean than in those of the northern hemisphere or arctic seas will (when they have no free passage to a higher latitude) have the effect to elevate their surface-level, sometimes it may even be to several feet above those having free communication with the Northern Ocean. Of this the Red Sea and Persian Gulf furnish conspicuous examples. Even the Bay of Panama may by this cause be found to be some feet above the Atlantic side, as is usually supposed.

By ascertaining the relative level of some of these seas, particularly between the Persian Gulf and the Mediterranean Sea, an approximate estimate might be made of how much higher equatorial waters are than those of the Arctic or Northern Ocean; for it may be calculated that as the Mediterranean Sea is to the equator in latitude and in the reduction of its waters, so will the reduction of the Northern Ocean and its depression be to the Mediterranean Sea in the comparative relation of their differences of latitude. Now it certainly requires no far-fetched philosophy to understand or render this reconcilable with the known rules of nature; the application of a little common sense is all that is needed to perceive that the ocean in itself, as an affinitive and incompressive fluid, is necessarily a motionless mass, susceptible of being excited into no continuous motal action in the nature of currents, except as a consequence of their constantly prevalent cause, such as are urged by unequal expansions and condensations of the aqueous constituents by difference of temperature, which difference being general to the whole ocean could not cause local currents only by the accumulation of moving waters into narrow channels; and this could only be effected by impediments to their general passage in the shape of shallows of lands and coast ranges.

This general tendency of the heated waters being necessarily either north or south, the cause of any departure is not in the currents themselves, nor in the general rule that regulates them, but in the obstructions to which they have to accommodate themselves. There is no more tendency in the waters of the ocean to form currents than there is in the water of a washerwoman's tub to do so, and the curious may produce precisely the same general system of currents in the tub as this unequal temperature produces in the ocean, the order only being reversed; let the center of the tub represent the equator, and place therein a lump of ice you will have the whole water in motion, a current in circularity, regularly descending under the ice and rising toward the side of the tub, or farthest removed from its condensing effects; these currents will decrease as the temperature becomes equal—when that is accomplished all is necessarily still as before.

There is but one rule in nature by which currents can be continued in a fluid substance without the continuous application of mechanical forces; this rule consists in the susceptibility of its molecular constituents for calorific expansion or their individual enlargements, by which they are displaced by molecules of a more condensed charactér, and these displacements take place vertically; there being less resistance in that direction, they would rise toward the surface. Expansion constantly taking place on an extended scale in the equatorial regions must elevate the waters above what would be a water-level were the whole ocean of equal temperature, by which we perceive waters will descend from the equator both north and south as a consequence of this inclination of these planes.

Therefore so long as the sun's exciting action operates unequally, there must continue to be oceanic currents, but of quite a different order from the accommodating ones described by geologists; and as the laws of nature are as immutable as their Originator, the idea of change in them is inadmissible; and so far as we find any evidence of the condition of primitive times, there must have been much less cause for currents then than now, there being then less land by which waters could have been deflected into narrow channels, and the temperature much more uniform.

The greater uniformity of temperature in former times has been a subject of much speculation, and still remains a problem with no expectancy of solution from the present schools of physical science;

which may be regarded as a proof that the elements from which they derive their conclusions must be in some manner defective.

Were even astronomy itself that perfect science it is so usually assumed to be, geologists would not have to appeal to it in vain for an explanation of the facts of the climatial differences between this and former times, how there came to be this observed change in the earth's temperature would be no longer a mystery. The very circumstance of there having been a change in the uniformity of the earth's temperature is a geological fact so associated with astronomical science, that were the principles of either properly understood, the whole matter would be so evident that "he who runs might read."

Astronomy and geology could have had no special distinction in their ultimate laws. What ruled the one must have regulated the other, so that contradictions could not have been consequent as they seem to be in this case, where the facts of geology prove that the earth in early times must have had different relations to the sun's action than such as prevails at the present day, while astronomers say that the facts of astronomy as conclusively prove that there could have been no such change.

There could have been but one general system for the accumulation of the materials of the earth's rocks at least, and but one general rule by which deposited matter could have been subdivided and characterized in the alternating conditions now existing, and these facts are fully established by the following circumstances:

First. Every condition of matter, recognized by the senses, is a secondary or forced condition, and thereby susceptible of being graduated into any other condition, and therefore it is that rocks of every character are found changing their textures and passing into each other in continuation of the same parallel beds.

Secondly. Nothing could have been added to the earth's matter by the grinding-down process; the disintegration of substances could not have been a generation of matter, for the rocks must have already existed, or they could not have been thus destroyed; and how much soever it might have been changed in quality by the operation, still the quantity would remain the same.

And, Thirdly. The matter of rocks not being self-originating, the stratified series of formations must have been accumulated as all other matter of the earth was, by the coalescence of bodies from external space.

We have already shown that there was a comparative suspension of these accessions about the time that coal measures were formed; still even then they were by no means wholly suspended, for we find their contributions to have been considerable, and, taken as a whole, were affinitively the best calculated for the formation of water, but could not have produced as great a quantity as was appropriated (during this long period of time) by the more solid matter. Hence the recession of the waters, and the rising of lands for the introduction of terrestrial vegetation.

But this period must have been unpropitious for the propagation of animal existence, the lands being subject to frequent inundations from coalescing bodies and the construction of water; their lives would have been too precarious under such a condition of things, nor would such times have been more favorable for the extensive propagation of marine organization while the depths of the sea were so fluctuating and uncertain.

When plants were washed from the higher lands that were projected above the waters, they would leave their seeds in the sediment of the receding seas, and as the lands were again bared to the atmosphere, these would spring into luxuriant growth, and propagate themselves over the plains, while marine organizations in these exposed situations must as certainly have perished. And, on the other hand, too great an increase in the depths of the sea would prove to be equally fatal to them, though no doubt there were many favorable locations and depths of sea for the propagation of tribes of marine animals through many successive generations; but terrestrial animals would have been totally destroyed by each overflow of these primitive lands, and hence it was they were not originated.

We have already contemplated the change which took place at the beginning of the new red sandstone series of deposits; then it was the ocean began again to rise over the earth by a repetition of oscillatory advances of elevation caused by successive additions to its quantity, and more than was required during the periods intervening the successive accessions and deposits which constitute all the vast series of rocks intermediate of the carbonaceous formations and super-cretaceous rocks.

We have abundant proof of this increase of the waters in the extensive accessions of solid matter received during this period, because many of them bear such unquestionable evidence of having been received in an ocean that must have been dry land before their accession, and these are often found stratified without so much regard to conformity with previous deposits as the preceding strata, which would signify that some considerable revolution or change had taken place in the general order of events. And with these large accessions of solid matter there must have been received at the same time, for reasons we have already seen, a corresponding accumulation of oceanic and atmospheric ingredients; and during these periods of accessions there could have been but few plants and animals, and those that were could have existed only in favorable locations, where the oscillations of the ocean and the destructive effect of falling meteoric matter was for the time less frequent, so as not wholly to exterminate either class. These successive oscillations explain the repeated alternations of fresh-water and marine deposits found in some localities, as that of the Purbeck beds in the Isle of Portland, etc. It explains, too, the footprints of animals, so often found in the red sandstone rocks, and that seem to have been adapted to the prevalent conditions of such times.

There could have been no period of accession when all portions of the earth were equally exposed to such vicissitudes; the effects from descending bodies would operate only over comparatively small portions of the earth's surface at the same time, and some locations may have remained undisturbed through long periods, during which organic forms may have propagated their species both on sea and on land.

But during all this period of oceanic increase agreeable to circumstantive conditions, all tribes of animals or plants would be constantly subject to be overwhelmed while in the full luxuriance of life by floods of waters or falls of more solid sedimentary matter, in which we now find their remains preserved as perpetual monuments, testifying to all time the character and condition of the inhabitants of such lands and seas, and the nature of the destructive casualties by which they were overtaken and interred.

These bear important testimony to the meteoric character and the quarter from whence these deposits must have come. How else could the waters of these areas have been charged with such quantities of sedimentary matter as to overwhelm creatures having the power of locomotion, and who under ordinary circumstances could have escaped?

When we inquire the reason for the partial suspension of deposits we speak of, and why they should again become abundant through a long period of subsequent time, we find a ready answer in the circumstance that these falling bodies were concentrating matter from the utmost boundaries of solar space, and were subject to a certain rule of affinitive effectivity as governed by distance, and depending on the combination of forces that controlled their motions.

Much would depend on where these bodies were primarily situated and what the circumstances of their aggregations, and their specialities as respected their general affinitive relations with remote bodies. Many of them may have been so nearly balanced between forces as to remain much longer suspended in space than others before contributing their matter to any member of our solar system; and besides these, the grand centralizing force of the bodies themselves being so various (depending upon the comparative energy of their own aggregated matter), many of them may have been so feeble as to be but little affected by the system to which they were tending. Thus we see that the periods of time required to overcome the effect of all other surrounding forces and accomplish their ultimate conjunction with the earth, must have been very irregular; and furthermore, the relative positions of the superior planets with the paths of these converging bodies must have had no little effect in intercepting what under other circumstances would have been made a part of our earth. We judge from the size and position of the inferior planets that they could have garnered up but a small comparative portion of these final ingatherings of this meteoric matter.

In contemplating the vast accessions made to the solid part of the earth between the carbonaceous era and that of the tertiary period, consisting altogether of but the nucleus portions of meteoric bodies, we must conclude this to have been but a small portion of the contributed quantity when compared with that of the aqueously disposed and insensible matter received at the same time, for in the general aggregate, these deposits being so extensive, we must infer that their contributions must have produced large formations of water; so much so as to have elevated the ocean once more over almost the whole earth, of which the relics found in the rocks of this period bear unquestionable record.

Now as these concentrating bodies were not conditioned alike or received at the same time, their differences would consist in the relative affinities of their molecular forms; and though these could not have constituted them either salt, marl, lime, clay, or even water, from their not possessing in themselves the necessary requisites for such formative consolidations, yet we find the matter furnished must have been, when subject to the earth's action, the most suitable for these substances, or they would not have been formed. The deluges of fresh-forming waters descending with the red sandstone deposits upon the exposed lands may have abraded them of much matter, and mixed it up with that then being received from external space, so as to have caused the deposit of heterogeneous materials which the constituent affinities would ultimately subdivide into concrete substances, such as we find in conglomerate beds.

We can not imagine that the detrital matter of these abraded lands could have already been consolidated into rocks of which these conglomerates are the water-worn fragments, for such could not have been held suspended in the water and let fall in such regularly formed beds, maintaining their parallelisms about as well as any other of the beds among which they are found interstratified; certainly there is but one process in nature that could have affected these conglomerate and other conditional relations of rocks and their ingredients. The passage of rocks into rocks, and the interpositions of formative severality in what must have had a cotemporaneous receptive origin, is certainly proof sufficient to show that there could have been but one general rule for all their relations, one formative process for all their textural conditions. Marl and sandstone beds are not only found passing into salt and gypsum beds, as if by transformation, but they are likewise often found inclosing to a very considerable extent quantities of rock salt and other concrete masses of differently conditioned substances; and frequently beds of salt are found to be of such depth as to occupy the space in parallel continuation of several depths of very differently conditioned strata by which it is flanked, and with which it alternates and blends in intermingling conjunction, so that it is at times difficult to tell where one terminates and the other begins. All this is certainly the most conclusive evidence of their all having had a cotemporaneous origin, that all were deposited at the same time as a continuation of the same parallel. It would be absurd to suppose that rock salt, either in mixture with marl and gypsum beds, or sandstone rocks, or inclosed in concrete substances, or existing in massive continuation of these beds, could have been a subsequent introduction, there being no possible method of accounting for the disappearance or displacement of the matter whose place the salt and gypsum masses now occupies. There is no consistent way of accounting for these associations of rocks, composed of matter so differently and peculiarly characterized and conditioned, but the one we have so repeatedly pointed out as depending upon the molecular affinities of their own matter as modified by the extraneous circumstances to which it was subject. At their junctions, these affinitive preferences of forms seem not to have been at once decided, which is further proof of this principle of affinitive formation; for the matter would seem by the peculiarity of its mixture of passages, and sharp or abrupt alternations of concrete aggregates, to have made a compromise among the constituent forces respecting the forms it should take in its final disposition.

Were the sandstones, marls, or clays (now associated with salt beds) really the abraded and water-worn matter of previously existing rocks, there must in such case necessarily have been a transmutation of this very eroded matter into salt rocks; for these very positions in continuation of the same parallel show that if one is eroded matter of older rocks, the other must necessarily be equally so. Now no one will suppose salt or gypsum rocks to have been eroded substances, there being much too great a contrast between them and other forms of matter; but if the differences between sand, salt, and gypsum, or other associate rocks are sufficient to prevent their being referred to the same origin, there is equally as much to preclude the possibility of their having proceeded from any two distinct rules of action. This is the dilemma presented by this association of formative conditions, from which there is no possible escape. Here the same parallel continuations are occupied by deposit as different as matter can well be, and which must have been accumulated at the same time, or they could not have been deposited on the same plane. This certainly reduces to a positive determination the fact, that if one was abraded and transported matter so must the others have been; and if the qualities of the one have been affected by the affinitive forces of its own matter, so has that of all the others. These are the two alternatives from which we must choose, and there being no possibility by which these rocks could have had a mechanical origin, they must necessarily be the result of their own affinitive and constituent energy. And if this is true of such rocks, why not of every other form of matter? If salt or gypsum masses in concrete form can not have been mechanically inclosed in or among other rocks, neither could many other substances that are found similarly situated. This would seem to be a needless repetition of argument proving the affinities of matter to be the cause of the forms of matter, for it is certainly multiplying proofs to sustain a proposition in itself self-evident, for every objective form in nature testifies to the fact of its having acquired such form by virtue of its own affinitive action with such qualifications as above stated, and there is no reason why the matter of rocks should be to this rule an exception.

If all the vast series of deposits which are superior to the coal formations and inferior to the tertiary beds be critically examined with reference to this general rule as the characterizer of their conditions, they will be found testifying to it in every particular, whether they be the conglomerate rocks, the breccian beds, the several grades of stratified sandstones, the salt rocks, the gypsum beds, the carbonates of lime, the carbonates of magnesia, variegated marl beds, clays, calcareous, oolitic, and dolomitic limestones, the variegated sands, the white chalk of England and France with its included flints, the intervening and overlying trappean rocks, and imbedded concretionary masses or crystalline forms, all, of whatever grade of character, are referable to this rule for their origin.

All, all, are equally, easily, and consistently explicable by this order of material affinity and no other; for who will say successfully that such associations are mechanical, or that the rounded flints so plentifully found in chalk beds are the water-worn fragments of broken-down flint rocks? or who will contend that the spherically-formed constituents of the oolitic beds are the rounded fragmentary particles or forms of rocks previously broken up into such miniature magnitudes? And what is to be said for the crystalline or other concrete masses of gypsum and rock salt or dolomitic rocks that are found inclosed in clays, marls, sands, or any other sort of rocks? What conceivable power could have made room for all the inclosed masses and left so little evidence of what disposition was made of all the displaced matter? A circumstance so peculiar is certainly a subject for some consideration, for when rocks are penetrated in any manner by others of a very different character, it requires to be explained, both how they came to be so intruded and what became of the matter in such positions as they now occupy. Surely they could not have possessed themselves of the spaces they now fill without dispossessing them in some manner of their previously contained matter by which some record must have been left of its disposition, but which we so invariably fail to find. All this vast quantity of matter now intervening between the coal formations and tertiary beds, and so variously characterized, being but the solidifying portions of the matter of meteoric bodies of various magnitudes, and received at irregular intervals, will be found to have been contributors to our earth under the general circumstances of another great increase of the waters of the ocean caused by the more frequent reception of such bodies, and not only by their more solid deposits filling up so much of the ocean's former bed, but the very extensive formations of water itself that would follow, as we have already seen from the accessions of such of their matter as was most favorably conditioned for aqueous combination.

As these bodies were received irregularly, and between more or less lengthy intervals, it will be perceived that this generally progressive increase of the waters of the ocean would be attended with many pauses or periods of intermissions, causing partial retrogressions of the waters, continuing through more or less lengthy periods of time, which would to some certain extent, where situations and conditions were favorable, alternate the deposits of fresh-water seas with formations that were generally marine.

Now it will require but small consideration of these circumstances to be satisfied that during this vastly lengthened period of fluctuations, vicissitudes, and uncertainties during this general increase of the ocean, that the existence and propagation of plants and animals must have been very uncertain and precarious, and therefore there need be but little expectation of finding their remains coextensive with the vast deposits of this period. But although not plentiful, there are evidences of certain tribes having colonized and contended for a continuation of their species in some of the most favorable localities, and at times to a very considerable extent; but the periods of repose seem not to have been sufficiently long for them to have multiplied themselves in any manner proportional to the deposits of this period, or with even any very lengthened continuation of their race, unless under the effect of favoring circumstances, of which examples are occasionally found in the oolitic and chalk beds. Now with regard to these beds themselves, and more particularly the chalk with its inclosed flints, what is to be said of them with respect to their derivation? They certainly furnish no argument in favor of their matter having been derived from the distraction of previously existing rocks, particularly in the condition in which it now is. They are of that character which seems to be altogether self-representative, having no known prototypes in any of the inferior formations of the earth's exterior from which their matter could have been derived; but while this is unquestionably so with respect to such an eroded origin as is usually assigned to the secondary strata, their condition is but in strict conformity with what must have been the effect of the affinitive forces of their own constituent matter, as ruled by its relative conditions when made a part of our earth.

Superior to this great series of deposits of which we have said all we deem essential in support of the system by which their matter must have been received and its forms assumed, there are yet other and no inconsiderable systems of formative character whose matter must have been deposited under a different order of circumstances, and embracing an extensive period of time much more favorable for the propagation of the fauna and flora that at this period began to people the earth more plentifully with their forms.

This was the epoch for another great recession of the water from the face of the most prominent portions of the earth's surface, and similar to that which we have already contemplated for the construction of the several coal fields.

The cretaceous formations furnish good proof of what were the elevation of the waters in general (when their matter was deposited), over what were lands during the reception of the matter constituting the coal-bearing rocks. This second general subsidence of the mighty ocean was again consequent, as before, from the more limited acquisitions to the earth, by her interception of descending bodies during the now final ingathering of such masses as were affinitively converging to the center of solar space; and from this, of the limited reception of materials for the further formation of water, so that the requisitions for the structural formation of rocks of this aqueous substance would be greater than the formative increase of such; and from this absorption would follow a corresponding reduction of the ocean-level. This reduction of the ocean by the transformation of its waters into rocks may be questioned by those who do not recognize the ocean as the ready reservoir from which the whole face of the earth receives all that is essential to her formative processes, whether crystalline, concrete, or organic.

In situations where water is not sufficiently supplied, there is proportional suspension of nature's productive operations; and if without the presence of water, this wide world would be but a barren waste. We may certainly infer more than a simple presence to be essential in conducing to nature's fertility. But as there are periods to processes, and compensatory equivalents of the proper character, for what is appropriated by one product of that of any other, which will finally terminate in conditions, when each will be equivalent to each, therefore we have nothing to fear from this appropriation of the waters of the ocean by the rocks of the earth. That the waters are used in the structural formation we have positive proof in the coral reefs already described; and these little artificers are manufacturing as extensively now as they ever have done at any former period in the world's history, and there is yet no sign of scarcity in materials which they employ.

That the ocean is supplied with limestone matter by submarine springs for the construction of such rocks by these creatures as is usually supposed, seems just so much like nonsense as to be considered akin to the other absurdities by which geologists are always endeavoring to make the earth disgorge from her interior the wherewithal to furnish and build up her exterior, as not to be worth one moment's serious consideration.

These coral rocks being formed to such an extent so far from where there could have possibly been furnished such supplies of this ingredient of lime, the ocean must have long ere now been exhausted of this matter unless the little artificers had the transmutative faculty of elaborating it according to their requirements from sea water, and this is to be considered but as one of the many ways by which the purposes of Providence are accomplished.

Admitting this convertibility of the waters, we perceive that during the lengthened term of the final ingathering of material bodies the intervals of their reception would become more and more extended, allowing a very slow but progressive reduction of the ocean-level by the appropriation of its waters in the solidifying rocks, by which the most prominent parts of her surface would, in the ratio of their relative heights, progressively appear above the surface of the receding ocean in shape of islands, surrounded by and often encircling shallow seas, favorable for the production and propagation of marine animals, which would then begin to multiply themselves abundantly.

But we infer from the solid matter received by the earth, and constituting the secondary formations, that by the termination of the upper members of this series (the cretaceous deposits) the greater part of the earth must have been so far under water as to have rendered it unfavorable for the existence and propagation of most, if not all of the marine organisms which peopled previous seas, and that terrestrial animals would find no rest for the soles of their feet. Succeeding or super-cretaceous beds show this to be the case, for all future types whose relics are contained in them are modified in character, fitting them for the changed condition of their dwelling-places and climatial peculiarities; and intermediate of these eras there must have been ages unfavorable to life in any thing like a general diffusion.

From this evident extinction of all races of inhabitants in one period to their reproduction in another, there could have been no progressive passage in their development, or even a reproduction by their fecundating powers.

The reduction of the ocean from a depth unfavorable to organized existence could have been effected only by the slow process of transformation of the aqueous matter into rocks, so there must have been a long period without organic life in sea or on land before their reproduction in new forms befitting the earth's condition on its re-emergence from the ocean. But though this period was unpropitious for organic propagations, it was by no means lost time; for it was highly essential for the welfare of the earth's prospective inhabitants that all these deposits should be long buried beneath the deep ocean, so as to acquire the affinitive consistency best befitting them to become the face of a teeming earth, and the most serviceable to the social relations of man. Had this matter been exposed before it became sufficiently consolidated, it would have all been speedily washed into the sea, or would never have acquired its present conditions. Not only must there have been a reproduction of marine organisms suited to the shallowing seas, but likewise a reproduction of plants and land animals. And no historic record can be more faithful in its chronicling of facts than are the monuments imbedded in the super-cretaceous rocks, and no less than the very relics of the fauna and flora of those periods when these rocks were deposited.

They are the historic recorders of the geological chronology of the times, demonstrating that there can be no error in the deductions evolved *à priori*, with which all these monumental teachings are so perfectly parallel and confirmatory.

On this general subsidence of the ocean-level there would follow a system of events somewhat analogous to what took place at the period when the matter now forming the coal fields was deposited, for then all the solidifying matter that fell upon the exposed lands, or into shallow seas, where the water could readily acquire motion, would be washed into more depressed portions of the then unequal surface, by the aqueous matter accompanying, forming, and falling with these deposits. And the same thing would again take place on the recession of the waters and reception of the deposits which constitute the tertiary formations. These are everywhere replete with remains of terrestrial plants and animals mixed up with marine organisms, all having been washed into shallow seas by inundation of fresh-forming waters from surrounding high lands, and received together with the tertiary accessions and detrital matter with which these remains are mixed. The analogy is even so far carried out that we often find nascent coal seams of no inconsiderable width interstratified with the rocks occupying the tertiary basins. Had these been as long and as deeply submerged beneath the sea as the coal measures proper had been, these brown imperfect coal seams (being the affinitive parallelism into which matter was subdividing itself), these carbonaceous and bituminous accumulations, assimilations, or affinitive transformations would have enlarged and more effectually perfected these seams until they had become good and valuable coal beds, a condition which some of them have in a great measure acquired even without the aid of these favoring circumstances.

We likewise find that the rocks of the tertiary basins have not even attained that lithological perfection of texture and solidity which characterizes the secondary systems of deposit and structure. An important and critical comparison of the two periods of coal and tertiary deposits would alone be sufficient to determine the validity of the process by which we undertake to demonstrate what must at all times have been the phenomenal expression of that order of dynamical law to which we so rigorously restrict ourselves. Nothing will account for the phenomenal fact of either period, unless associated with the full admission of oceanic recession as a general rule, and that caused by a diminished reception of matter in general during countless ages, in which the waters of the ocean were metamorphosed into the consolidating rocks of the earth. This accounts for the general similitude between the coal measures and tertiary basins, whatever their level or other relative condition with respect to the ocean or each other. The abundant remains of terrestrial plants in the coal measures is good proof that the ocean did not then prevail over the whole earth as it had previously done, and that the prevalence of dry lands could not have been immediate nor partial in its locality, but intermittingly progressive over both hemispheres at the same time, wherever coal fields or tertiary beds are found.

Thus the whole coal-bearing rocks of the world, situated at their several relative elevations above the present level of the ocean, were made to occupy the depressions of the primitive earth and sea-bottom, being in themselves evidence of having been the only solidifying accessions of matter made to the earth during these long periods, and received under the same generally effective order of formative circumstances, and a general but intermissive retrogression of the ocean-level.

Hence, on finding all the super-cretaceous deposits occupying depressions, and containing in themselves the relics of a terrestrial flora and fauna together with marine products, we must infer they had been subject to a similar order of circumstances with the coal-bearing deposits proper, and that these general recessions of the ocean prevailed all over the face of the globe at the same time, from their most elevated to their most depressed localities. The usual idea that these were the estuary deposits of great rivers flowing cotemporaneously into similarly conditioned seas, on whatever area of the earth they may now be found, and that their alternations of fresh-water and marine strata was the consequence of their own local heavings up and sinkings down above and below the general ocean-level, is too far-fetched to require further comment.

The general features of the tertiary formations make them, like the coal measures, referable to the same general cause, the progressive subsidence of the ocean; so great a similarity of condition between systems so widely separated and divisionally marked could not have been the result of a different order of causes or fortuitous casualties. This last general recession must have occupied a longer period of time than finite minds can well comprehend or enumerate by any order of initial numbers that may be adopted; this is fully proved by the paleontological records of the period, for there are contained in the rocks the remains of countless generations of creatures that must have lived and died, succeeded by other and different tribes in their prolonged generations, through a series of successive changes adapted to the different conditions and relative positions of land and sea.

During this slow subsidence of the ocean, as the waters shallowed on the elevated portions of the solidifying surface, these, as we have previously remarked, would be subject to constant degradation from the action of the shallow and retiring seas, from the atmosphere, and from the action of the deluges of new-forming waters occasionally falling upon them and washing them into the surrounding ocean. From this general subsidence, and the unequal surface of the new-formed earth, there would rise in the ocean in succession a multitude of islands, at first small and isolated; these islands would progressively enlarge their sea margins so as to spread out into connection above the common sea-level, and in such continuations as would often inclose seas, and not unfrequently isolate them entirely from the general ocean, so that in process of time, when the sea had receded below the inclosing barriers themselves, and they having been long detained in such isolation would, from time to time, as they received fresh accessions, become so overcharged as to burst their barriers and empty themselves into the general ocean, and not unfrequently to admit again the ingress of the ocean into these isolated seas.

During the slow subsidence of these tertiary seas they were no doubt many times raised by large accessions, so as to again elevate the waters back upon the land from which it had long receded, thus causing alternating deposits of fresh and marine character. The general shallowing of the waters, and their action upon imperfectly consolidated deposits, would remove much of them to less exposed situations over the inclined planes of the emerging lands, so that in many cases the more primary rocks would be denuded of much of their superimposed matter with which they had been covered, and which would remain undisturbed in deep seas; for in such seas any attitude assumed by one deposit would be conformed to by succeeding ones, as we have already demonstrated. Had all the aggregating matter of the earth at all times descended through an atmosphere and an ocean, a closer approximation to the horizontal must have been the rule of deposit; but there was a time when a different order prevailed, when there could not have been a drop of water on the face of the whole earth, when there was neither atmosphere nor ocean to spread out the accumulating accessions, and then they must have been piled heaps upon heaps in all the irregularity such dry impalpable matter could take.

And this constituted the granite foundation of or floor on which all stratified deposits had to rest and conform; they being let fall and disseminated in both atmosphere and ocean, and deposited in deep seas amid profound tranquillity, would easily accommodate themselves to the contorted foundation floor. Thus our earth acquired basins for the ocean, mountains for the cataract, islands and continents for the residence of God's creatures and propagation of their kinds, with continuous depressions in the lands through which meandering rivers carry the surplus waters to the sea, and by which means we have all this and almost every other existing condition without one convulsive upheaval or any tearing or fusing and exploding out of the earth's internal parts to furnish her with her surface-matter.

Chapter Sixteen.

The Moon—Last General Subsidence of the Ocean—Alternations of Marine and Fresh-water Deposits—Extent and Character of Igneous Action—Last Revolution on the Earth's Surface—Its Extent and Cause—No Evidence of the Human Race—Noah's Flood—Its Limited Extent—Causes of Change in the Earth's Temperature—Conclusion.

THE primitive irregularity with which the earth received her matter before she was provided with ocean or atmosphere to distribute the accessions, would cause her external form to resemble descriptions given of the moon's surface, only still more imposing because of her greater boldness of outline.

The moon is an accumulation of meteoric masses without ever having had the benefit of atmosphere or ocean to equalize them. The earth is likewise an accumulation of what must have been spherical masses, which all the effect of both atmosphere and ocean, acting since their first formation until now, have been unable to reduce to level sphericity. So that in place of the upheavals of mountains, islands, and continents, since the deposit of the primitive strata, we have had the converse of this order of action in the constant degradation of what was the most elevated by the action of the ocean and the atmosphere; still we have remaining all that is essential, or that we seem to require of irregularity in surface, for notwithstanding her accessions and degradations have, ever since the formation of her waters, been contributing to the filling up of her depressions, and reducing her prominences to greater uniformity of level, she is still far from being that equable plain to which the efforts of nature are constantly tending to reduce her.

This last general subsidence of the ocean, with its occasional oscillations continuing through countless ages, while the earth received her final contributions, explains the conditions of formative action during that geological period when she was receiving the super-cretaceous deposits, and bringing forward her faunal and floral developments to the perfection in which she presented them to man.

It accounts for the alternations of marine and fresh-water deposits found interstratified in tertiary basins from the rise (and readmission into these depressions) of the oceanic waters in temporary elevations caused by occasional accessions of aqueous matter. It accounts clearly for the kindred character of the isolated tertiary formations with the former coal fields, and for their occupying the depressions or least exposed situations of former sea beds.

It accounts for the lakeustern deposits by the isolating of internal seas, and their subsequent transformation into fresh-water lakes, or deep depressions subsequently filled by detrital matter brought down by waters from the inclosing high lands incorporated with the terrestrial exuvia of plants and animals, and thus often mixing up the fresh-water deposits with those of the marine.

It accounts, too, for the intermixture among these rocks of remains of terrestrial plants and animals, they being washed from surrounding. inclinations by the floods of water accompanying such accessions of solid matter. The agitations and flowings of these marine basins, caused by the sweeping floods, would readily occasion these admixtures of marine with terrestrial remains to spread over the beds of these land-locked seas. And these seas, by repetitions of meteoric and other effective agencies, would finally be filled up with these geological systems of super-cretaceous formation, that are now found to furnish so plentifully the organic representatives of the prevalent condition of these tertiary times. These are commonly attributed to the transporting effect of mighty rivers in despite of the evidence of their having been at this time no existing lands of that extent from which any such rivers could have flowed, the present continents being at that period but a cluster of islands, inland seas, lakes, marshes, and lagoons, subject to transformation by degradation, bursting of barriers, evaporations, fillings up by influxes, and final expansion (from oceanic depressions) into continents. We could not possibly have had a more truthful record of any thing than we have of all this, as testified to by the creatures who have left their remains as little less than living evidence of what were the conditions on the earth's surface during their day.

For all these changes and conditions we have no need of the instrumentality of great river currents flowing from, no one knows where, and charged with sorts and conditions of more solid matter from sources equally inconceivable and unknown, and alternating each other, nobody knows how, only that theoretical geologists will have it so, leaving the unsatisfied to content themselves as best they can.

If this general cause for the geological formations effected during the vast tertiary cycle required further confirmation than is furnished by its own self-testifying facts, we shall find them plentifully supplied by the organic remains preserved in these tertiary prolongations; they, if not misconstrued, tell a beautiful tale of the passing events of their times. They were of course adapted perfectly and particularly to the conditions then existing; and thus their conformations as fully and truthfully explain what these conditions were, as if they now existed for examination; for in observance of nature's rule of right, organic creatures could not have been misconstructed with reference to the conditions with which they were associated, otherwise there would have been no necessity for changing the types and specific characteristics of organic creatures during the changing conditions and progressive processes of the earth's stratified construction, as we find has been done again and again.

The characteristics of these successive chroniclers that have so faithfully transmitted to us the imperishable records of remote ages, by which we are informed of the consecutive occurrences in phenomenal geology as connected with the earth's general condition during her long progression up to present times, we need not here name; they may be found chronologically specified in almost every good work of descriptive geology; but this much we may say, that their information is certainly in full corroboration of the facts we so readily deduce from principles *à priori*.

Thus seeing under what conditions of the earth these tertiary formations were effected, we can not still perceive wherein their affinitive characteristics can be fully explained on any other principles than those by which we have accounted for the character and associate condition of rocks more remote in the chronological order of times. They may not have that perfection of structural solidity or soundness of texture that more particularly characterize the older rocks; but that is, in a great measure, to be accounted for by their not being so long submerged beneath the ocean, and by their accessions of solidifying matter being often very much mixed up with the debris of older date washed down from the surrounding high lands of a character that could not readily assimilate with that newly acquired. These tertiary formations are therefore to be regarded as only a repetition (under different circumstances and relations of land and water) of the same process and character of rock-forming matter already considered; in these super-cretaceous basins we find conglomerate beds, sandstones, clays, marls, limes, sulphate of lime, coal seams, and even rock salt, interstratifying and associating with each other in such a manner as can be accounted for no otherwise than by the affinitive action of their own matter operating under the circumstances to which it was subject.

We have demonstrated the absurdity of calculating on oceanic currents or extensive rivers having transported, subdivided, and associated rocks in such regular parallelisms as they now present themselves in the several geological systems; and if our deductions of the conditions of land and their effects upon forming substances during tertiary times is not conclusive evidence against the existence of large rapid rivers, we should like to know by what possible process these rivers could have so regularly spread out, subdivided, and alternated these several assimilated sorts with such nice discrimination as they seem to signify?

We can well imagine rivers transporting solid particles in suspension, or of their urging on the more ponderable substances of abraded lands into the seas, where they emptied themselves, and there letting this transported matter fall as they mingled with the waters of the ocean and ceased their transporting velocity. But we can not possibly conceive of rivers disseminating matter held in suspension, such as coarse sand and gravel, over areas of hundreds of square miles of sea-bottom, and so far removed from what could have been their mouths. Neither can we perceive how this ponderable matter, which could only have rolled along the river's bottom, could have been otherwise than precipitated over a *talus* into deep seas with but little more relation to horizontality than about forty-five degrees, for the current of the rivers could not have been continued far into the sea, and even if they had the coincidence of their respective bottoms, could not have been that of equality, consequently would not have been such as that they could have urged the sands and gravels along the bottom of the seas and spread them out so uniformly. Certainly no waters nor currents of waters could have held rounded pebbles or coarse sands in suspension equally disseminated from which they could have been let fall so uniformly in beds as are found to be the stratified conglomerate; neither could they have interstratified themselves with such finely comminuted matter as forms the clays, limes, and marls on which they rest; for they being mud at the period of the conglomerate deposit, must have been wholly swept away by such force of water as could have urged forward such beds of rounded pebbles as often characterize the conglomerate rock. But even if the mud had not been washed away, we are still at a loss to understand how the pebbles and gravels could be rolled so far over soft mud without sinking into and becoming wholly submerged in such a soft bottom. Nor can we see any reason for the sudden abatement of this force, which could have effected the transportation and outspreading of these gravel beds, and the transformation into the perfect tranquillity which the succeeding rocks would seem to indicate.

These suddenly alternating and sharp transitions from a force that could only have effected the acquisition of soft sedimentary deposits to a force equal to the transportation and deposition of rounded fragments of hard rock, and they often of no inconsiderable size, and again as suddenly to have been only efficient in the transporting and letting fall of finely comminuted matter, however reconcilable with the reasonings of physicists, are certainly in but little accordance with common sense, or any known principles or processes of nature, and we regard all the assumed causes that are said to have so suddenly alternated the stratified beds in general to be in the same category, for not one principle yet named in scientific circles as giving effect to formative character could have caused the sudden or sharp transitions recognized in the several systems of rocks, for what is there in either or in all of the contemplated causes that could so abruptly have put an end to one species of deposit and so suddenly have substituted another.

Were the conglomerate beds found in irregular masses, filling what may have been depressions of the sea-bottom in place of being interstratified in such regular parallelisms with other and more fine-textured rocks, we should not be so much surprised at the supposition of their constituent forms having been urged to such situations by the force of waters could we only conceive from whence so much of this fragmentary matter could have been derived. But contemplating not only the conglomerate beds, but all other conditions of stratified rocks as they are found associated in the several tertiary basins, we conceive them to be altogether inexplicable on any other principle than that deducible from the force of their own affinities, for what else could have formed the gypsums and fossil-bearing beds of the Paris basin, or clays and sands of the London basin, or the vertical and beautifully colored sands, clays, and marls of the Isle of Wight, so well known to geologists? What but the affinities of the matter itself could have caused such infinite variety in texture and shade of color, and in stratified layers so endless, and in every imaginable combination, which no circumstances in nature external of their own matter and its mode of action could by any possibility have effected. We can not conceive why it should be calculated that such an assorting of matter could have taken place by the mechanical action of the waters or any other order of exterior agencies. Nor could this matter have so separated as in the sands, clays, and marls of the Isle of Wight, even by its own affinities, unless the planes of strata had approximated very much to a perpendicular, for otherwise the affinities would have had the common force of gravity in opposition to the subdivision into such delicately thin layers. In all rocks stratified with less inclination to the horizon there is to be found no such an example of delicately divided strata, for gravity must have so ruled that their subdivisional planes of affinitive stratification should be farther apart, while these affinitive forces operating laterally would be free to subdivide the matter into as many separate parallels as the constituent forces found it the most convenient to resolve it. The absurdity of these delicately stratified layers in long-continued repetition of alternating sands, clays, and marls having been upheaved on end subsequently to their subdivisional assortments of matter in these parallel planes, seems to us to be so self-evident as to require no special attempt at refutation. We would suppose it sufficient to say that the rocks of the earth are to be regarded as rather stubborn things to be tossed and tilted about like a pack of cards or twisted and contorted like the folds of a wet blanket, and particularly this sectional series of sands that are said to have been set on edge, while they contain no fractural evidence of the force which could have thus given to them their verticity, indicating at least an operation of no little particularity.

This is but another example of the extraordinary powers that are assumed to have upturned the world's rocks, and extraordinary this would indeed have been could it have thus set on end this long continuation of alternating sands without in the least disturbing the relation of these alternating varieties of strata. If we are to take for granted all we are told about the upheavings and twistings of the earth's stratified outer crust in general, we must necessarily conclude that nature had very much mistaken constructive effect when forming the rocks in positional attitudes, from which they had to be forced in giving the final form to the world; for agreeable to the same system of teaching it would seem as if none of them had been formed in the same positions in which they are now found, but that such has been subsequently attained by forcible rendings, tossings, and upturnings, in rendering them subservient to the final formation of a world.

Now why is it that such a system of procedure should be attributed to nature as that the rocks of the earth were not originated in their proper positions? she surely could not have mistaken her measures, and if by the affinities of her matter she has formed a world, and the outward things of a world, there can be no reason why by the same effective method she may not have originated the stratified or other rocks of the earth in their right positions of relative attitude, rather than to have been restricted to any rule of horizontality requiring subsequent revolution by the effect of some inconceivable force. Besides the action of water in the origination of our earth's stratified beds, there is usually much said with respect to the effect which igneous action is assumed to have had in originating many associate rocks and their relative positions with reference to each other, and the aqueous strata among whom they are supposed to have been intruded. Now, seeing that in some certain degree such must be recognized, we will contemplate in this formative connection what may have been the character and extent of this agency to which so much has been attributed, and of which there are no very conclusive evidence in the primary or secondary formations, at least so far as the exhibition of any thing like what may be regarded as having been volcanic vents or craters of igneous ejectment. Volcanic cones, or any evidence of such, do not manifest themselves until during the passage of the tertiary period; and even when they do present themselves, that is by no means to be regarded as indicative of any period when the whole matter of our earth was in a condition of incandescence, or of the existing fluidity of her whole internal mass, as geologists so usually assume to be the case. We have fully demonstrated heat to be but the exciting effect of the molecular activity of substances, as induced by extraneous cause, or by the affinitive metamorphoses of the substances themselves.

Now what force could have caused and kept up such excitement in a mass of matter like that of our earth as conditioned by its affinitive forces and superimposed pressure? Surely under any such conditions calorific action would have been constantly subject to cessation, because of the extinguishing effect of the affinities of the very matter among which it was operating.

The affinitive quiescence of every substance, whether sensible or insensible, can only be excited into activity by a correspondingly conditioned force; and as force and motion in an inertial mass are equal, the force causing the excitement could be no longer continuous than the time required for the inertial force of the affinitive mass to reduce it again to rest, consequently, for a continuous excitement, there must be a continuous application of the exciting power; but this could not be in perpetuity as consequent from any chemical metamorphosis of the earth's matter, for that is a process that would ultimately operate its own consummation, and comparatively soon terminate any excitement of which it could have been the cause. Had the earth, therefore, even been created in igneous fusion or in any incandescent state, as it is so much the fashion to fancy, the whole mass would have become motionless perhaps many million years ago.

To account, therefore, for the volcanic action of the tertiary period and of our own times, we have only to consider that the matter of meteoric bodies, when made a part of our earth in such manner as we have already seen, must have been affinitively very differently conditioned from each other; and as contributors, they may even at times have constituted the differently conditioned members of miniature systems circulating round each other during general convergence, and so have contributed their unassimilated sorts of matter at the same time. This heterogeneous intermingling of their matter on the earth's surface during their common coalescence, and under circumstances unfavorable for the immediate satisfaction of its chemical and constructive affinities, conditioned as it must have been immediately before the formation of water, may have often long remained under circumstances unfavorable for its more perfect affiliation, and consequently would continue inactive until aqueous saturation or other favoring circumstances conditioned it for the exercise of its affinitive or chemical energy. This chemical excitement, when once induced, being in its turn generative of calorific excitement, and these calorific pulsations not being readily imparted to or transmissible by the surrounding rocks in outward radiation, would become more condensed, and so cause progressive increase of temperature; this increase being still more and more favorable for affinitive action, would on its part more and more hasten the increase of calorific action, until the rocks themselves ultimately became fluid; then the constituent molecules of differently characterized matter would more readily flow together in satisfaction of their several affinitive preferences, and in disregard of all aqueous agency, only in so far as its being effective in first originating these excitements. We may readily conceive the coalescence of matter so primitively conditioned and mixed up as to remain affinitively ineffectual for formative action until so aqueously associated and circumstanced, as that it would so far become effective as to induce sufficient calorific excitement to cause such reciprocity of action between the chemical and calorific affinities as would produce igneous fusion, or even incandescence; and this chemically induced action would only be referable to certain geological eras and particular localities, as the places and periods of its activity, and without calculating on all matter being thus affinitively conditioned; for the chemical susceptibilities, in much of the primitive matter, must have been satisfied in its fall, on first association, so as no longer to be susceptible of any such high subsequent excitement. But such as was subject to this affinitive action and formative effects in future time would, by the certain law of the expansion of substances, by their elevation of temperature, not only enlarge their own mass, until they attained a state of fusion, but by raising the temperature of surrounding rocks that yet retained their solidity, would so crowd the fluid mass, till, for lack of space in which to expand, it would accumulate sufficient force to raise in some certain degree the incumbent rocks, the vertical being the only possible direction in which resistance to such expansion could be overcome.

This swelling upward of the igneous mass would soon cause a rupture of the incumbent rocks, from their want of expansive elasticity; and through such fractures as presented the least resistance, the igneous fluid would force and fuse its way upward; and in proportion as the expansive pressure increased below, so would the column of melted lava rise; this being more easily elevated than the whole incumbent mass of rocks, would become the indicator of internal pressure, as the mercurial column is to the thermometer; but being only of about the same specific gravity of the rocks into which it was intersectingly penetrating, it could not possibly have forced itself between them in interstratified parallelisms, as geologists so constantly calculate upon as having been igneous beds, such as those intermediate trappean rocks, which they say were thus originated, though they furnish no evidence of such columns of lava being elevated far above the summit-level of the incumbent rocks which it is assumed to have thus upraised; for surely if the gravitating pressure of this perpendicular column was not more per square inch above the parallel of intrusion (either by its greater specific gravity or by its elevation) than the pressures of the incumbent rocks thus upraised, it could not possibly have forced itself between them.

Now there being no other possibility in nature by which beds of igneous matter could have been intruded between beds of stratified rocks, except by the elevation of an igneous column considerably above the rocks incumbent on the intrusive parallel—for equal weight against equal weight would furnish no intrusive force, but on the contrary would only be such a balance as could be effective of no separation of strata and intrusion of lava beds—it is very evident that no little additional force would be required thus to separate beds from beds and thrust in matter for intermediate rocks.

Were there no other proof of the perfect absurdity of the proposition that igneous beds were intruded in extensive parallel continuations between stratified rocks than this, it alone is sufficient to put the matter forever at rest; for how could a column of liquid rock have acquired the elevation by which its pressure could have parted the strata and forced in the intermediate fluid? Had volcanic craters caused such mountains as now send forth their lava streams—mountains often many thousand feet, and even miles, above the general ocean-level—had they been formed at the time the trappean beds were intruded (if intruded at all), there would be some reason for the supposition of such intrusions, by assigning such an elevated head as may have thus had force sufficient to effect the separation of beds, and to occupy the intermediate spaces thus produced; but unfortunately for the followers of this intrusive doctrine, no such things as volcanic mountains were in existence during the primary and secondary periods, among whose deposits these rocks assumed to have had an igneous origin are found so plentifully interspersed.

The accumulations of which all the geological systems of these periods are composed having been deposited in the sea, up through which no columns of melted rock could possibly have elevated themselves, they must have been elevated above the general surface of the ocean before they could have acquired vertical pressure sufficient to force into position such intrusive beds of trappean rock as are often found between stratified deposits. But this could not have been. for we find among none of the trap rocks a single vestige of any volcanic crater or conical mountain of the required elevation which could have ejected or intruded them; nor could there have been any such igneous intrusion as we hear so much about. We here perceive that such force could not have been consequent from vertical pressure, and it is equally evident that no force could have come from below, of fluid or any other character, such as to have separated stratified beds without causing transverse fractures in the uplifted rocks through which fluid lava could more readily elevate itself, than in raising the whole mass of incumbent rocks.

Thus we conclusively demonstrate the total impossibility of any such origin to these rocks as is assigned by geologists even in disregard of all consistency in physical conduct. But with this subject we will now have done, and will proceed to the consideration of such lava columns as are generated and progressively elevated by calorific expansions below, and without the possibility, as we have now seen, of spreading out intermediate of the rocks up through which they may be forced to rise as a consequence of the expansion of matter by calorific action; for matter at a high temperature must have more space than the same quantity of matter at a low temperature would require; and this expanding fluid would necessarily flow up through the least resisting chasm caused in the incumbent rocks, and would rise in a progressive manner as the chemical and calorific processes extended themselves in the substances from which these columns thus proceeded. When first fusing their way up through the superimposed rocks, they would cause but few convulsive exhibitions of their powers, because of there being interposed but few gaseous or explosive substances, and these only when near the surface, which would soon be exploded or fused down into their own mass, thus making their way to the surface, which, when there, by flowing over and mixing their molten matter with the fragmentary and upraised rocks, would elevate a mound of more or less magnitude, and thus relieve the internal mass of some part of its pressure. They would not only thus constitute themselves columns of escape for so much of the internal lava as had not sufficient space under such calorific excitement, but they would at the same time be the medium through which the excess of this very excitement itself, by which they were fused, would escape so as to reduce the internal pressure, and by which cause these fluid columns themselves subside more or less within the mouths of these new-formed craters ; for when these internal igneous masses were thus put in free communication with the atmosphere, they would thereby be much more readily discharged of their calorific excitement than by the usual radiation into surrounding rocks, the atmosphere being the most ready conductor and disposer of this calorific action. Internal heat thus progressively escaping would become at times so reduced as to be insufficient to preserve the apex of these columns of escapement in their fluid state, so that they may often become solid and cease receding to their source by thus solidifying as a shaft in the aperture through which they had ascended, and so would cease for a time all outward signs of volcanic action. But these columns with their solid or semi-fluid apexes being now bad conductors of this internal heat, would no longer sink down by the shrinking of their base, as consequent from further calorific escapement, while the chemical action within having been subdued or partially suspended in consequence of this general reduction of temperature, would again progressively expand the whole igneous mass by the further extension of its effects among the internal rocks, and so would induce another accumulation of igneous excitement and consequent pressure, preparatory to another paroxysm or external outburst, by again forcing up the fused columns as before ; and they having to make their way against all obstacles of aqueous or other matter that might have intruded into the chasms or fissures during the recession of the igneous matter, would cause paroxysms of much more intensity than at first.

This being exploded and thrown out with more or less violence, because of this quantity of suddenly expanding matter coming in contact with these advancing columns of incandescent lava, may often be the occasion of much internal agitation among the rocks of the earth while these igneous columns are rising upward. But all such convulsions of our earth, however much they may at times be felt, must necessarily be of but comparatively superficial character; for were there even substances susceptible of such gaseous and explosive expansion at the foci of volcanic action, or anywhere very deep down in the earth, they would be altogether precluded from such expansion by the amount of pressure to be overcome before they could thus expand themselves. But when these antagonistical forces are immediately and effectively opposed to each other, the aqueous and other substances that are resolvable into vast expansion by excess of heat, may frequently be in such interposition as to discharge the advancing seas of lava of so much of their calorific excitement as frequently to make them recede back to their source even before reaching the surface.

Thus this chemical action, in affinitive satisfaction of molecular association, and the calorific action induced by affinitive excitement, being reciprocally generative of each other in the earth's interior, would necessarily extend their effective operations now generated, so long as they found matter in unsatisfied mixtures; and during this process, which may in many instances be extended to thousands of years, *these* actions would manifest themselves occasionally by paroxysmal outbursts, with intervening periods of seeming repose of longer or shorter duration. Such volcanic vents once formed, would continue to be the channels or avenues for the escapement of all surcharged heat or fluid expansion, however far the process might internally extend itself, until there was no further affinitive cause for such chemical action in that internal area of the earth's rocks as could generate sufficient force to send the subterranean lava to the surface, in which case there would be a progressive abatement of paroxysmal action at the surface, until it became no longer recognizable, and nothing left but these extinct craters to tell that such had ever been.

We have thus briefly given the general history of the cause, origination, progression, and termination of volcanic action, from which every phenomenal modification of this species of effectivity may be readily inferred, and from which we may safely calculate of it as having been variously effective among many areas of our earth's internal rocks, so that their matter may often have been under the more modified exercise of such affinitive action as to beget in them temperatures of all grades, from the lowest to that which exhibits itself as we have seen on the surface, by its igneous outbursts, and so often imparting this calorific excitement to the surrounding rocks, without any outward exhibition therefrom, or to substances having an explosive and expansive tendency only manifesting itself in such convulsive heavings and tremblings of the earth as are recognized in the earthquake.

We may readily perceive the reason why volcanic action as a general rule prevails more among the mountains than in the plains, even with the ocean included; for these mountain masses being deep-rooted and received in mass, and much of it together, both as regards time and quantity, and immediately anterior to the formation of water, this matter would often, under such circumstances, be in that condition of affinitive heterogeneity which would more incapacitate it for the ready assimilation of its own constituent ingredients than would matter as received under ordinary circumstances and between periods of frequent intermission. The matter of these mountains being usually of granitic character accounts for the conditions of things during its reception, and signifying that it was neither received in water nor in a condition by which it could expand and flow out into a plain by the pressure of its own mass, or it would not have been thus heaped up into mountains subject to the affinitive action of future times.

Before this world became the safe or fitting abode for creatures who could calculate coming events, or in any way apprehend casualties from the recollection of past occurrences, she was yet destined to undergo one more great revolution in her surface-relations, and this must have been at least operative over the whole northern hemisphere, and must have been of such a character as to have torn up the rocks, and even, we may almost say, the very mountains by their roots, and spread their ruins in broadcast, far and wide over the plains, which phenomenal exhibition of wide-spread ruins is now recognized as the erratic block or diluvial drift period.

Geologists find phenomenal facts recording this last revolutionary process that has prevailed to very considerable extent on the surface of the earth, but they can not realize in them the causes that could have torn up and transported such immense masses of rock and other matter. This has been and still is a subject of much speculation, for while the facts of such origin and transportation of ruins are evident to all, geologists have come to no permanent decision with respect to the cause or conceivable circumstances by which they can be sensibly and satisfactorily accounted for, at least so we should say on seeing their glacier and iceberg propositions, which would be more difficult to account for than the phenomena they are sought to explain.

Now that the favorite terms, igneous action, volcanic action, internal force, and upheaving of the earth, so often used by geologists as indicating the cause of most of their phenomena are even by themselves conceived to be altogether inapplicable in accounting for the phenomena in question, they find themselves adrift on the wide sea of conjecture without either chart, compass, or landmark by which to direct their way; they can neither satisfy themselves or others that these facts are the phenomenal effects of the heavings up of the earth, slidings down of glacier mountains, or of islands of ice set adrift in the polar ocean, or whether these causes, acting singly or in combination, could have been effective of such phenomena in any measure.

Now if that system by which we have resolved all antecedent phenomena be really the system of nature, as we assume, it will not fail us now in the resolution of this important problem, for the universe being a unital severality, the elementary principles that can properly explain any portion of the great physical problem are accountable for every separate fact, as being but a part of the unital whole.

We have already seen by what means elementary principles made up spherical masses and caused their convergence to solar centers. We have contemplated a condition of aggregating bodies as severally situated within the extended confines of solar spheres. We have observed how some of their efforts at solar convergence have been defeated, and they as pilgrim planets doomed to wander in perpetual

These bodies, because of their low grade of energy and consequent deficiency of momentum, would not be perpetuated in a motion of circularity round the earth (like the moon), neither would they be elongated into a ring round her, like the rings surrounding Saturn; but they would be compelled to approach her in spiral convolutions, first of an elliptical form, because of the earth forming the strongest foci of restraining force, and the sun forming the external foci or attractive center to which the major axis of the elliptical convolutions would be directed; the consequence of this would be, that on their nearing the earth their velocities would necessarily become so excessive as to far exceed (in their eccentric motions around the globe) the speed of her surface-rotation round her own axis, by which, and the attraction of these spirally falling and fast-flying bodies, the earth's water would necessarily have acquired a motion far greater than was imparted by their own rotary momentum in common with the general mass. And the matter of these gaseous bodies when mixing with the earth's atmosphere would likewise impart to it the rapidity of their own motion, so that while the earth was continuing her own rotary motion round her own axis, the waters of the ocean would be acquiring a much greater impetus, by which they would be urged round from west to east with much greater speed than the earth's mass in general; but they being restrained by the friction of their bed, and by their own inertia, the atmosphere, being more easily urged into motion than they, would acquire a still greater velocity than these waters.

This external attraction inducing such accelerated motion of the ocean, and being more particularly in the northern part of the northern hemisphere, would, to some considerable extent, have a tendency to draw down the waters of the equator, and thus increase the polar seas; but this effect would be more particularly at first, and inconsiderable when compared with the matter of these descending bodies when transformed into water by the effect of the earth's affinitive action and pressure of envelope, which, forming and condensing in immense floods under such acquired velocity, would necessarily swell the waters of the northern ocean far over the lands, and being thus elevated in those regions would necessarily flow south in gravitating equalization of water-level; but having in itself acquired a powerful eastward motion (for reasons already given), the whole northern ocean would thereby not only be elevated over the lands, but would likewise be in powerful motion in the direction of east by south; and the higher the latitude the more easterly the general motion, because of the attraction in that direction and full force of the coalescing meteoric matter, while as the waters descended south, by being more and more removed from meteoric influence, their southern direction would more particularly and in a progressive manner prevail.

Here we have all the elements that are required in the solution of this great and important geological problem of the displacement and transportation of such vast quantities of massive rock and other matter that is found more or less spread over the whole northern hemisphere, and to account for which geologists have long applied themselves diligently but unsuccessfully, while we encounter no difficulty in solving this great question by the same rule as that in which we have seen the problems of general physics so satisfactorily accounted for thus far.

We have already fully demonstrated that nature effectuates all her phenomena by the instrumentality of but one order of ultimate and elementary means, of which we have deduced the character, and by this same order of instrumentality we are thus enabled satisfactorily and conclusively to solve the problem of their several existences, even including this last, which has been the cause of so much unsound speculation and profitless conjecture. Nature had but one way in which the whole earth's mass could have been accumulated; the order of reception would, therefore, be very much the same for all, whether the matter be now conditioned as solid or fluid, sensible or insensible; but there may have been much variety in the condition and quantity of the constituent matter of the bodies contributed, and from which, as we have seen, the future circumstances and associate affinities have furnished us with the existing conditions or kinds that are enumerated in the chemical catalogues.

These last bodies seem to have been constructed, in a very great measure, of matter most readily transformable into water when subject to such circumstances as would so reduce it. And these cometically constituted bodies must have approached the earth more in the manner of satellites that could not altogether sustain themselves in circulation round the earth than most other of the earth's accessions; they would likewise have to encounter on their descent the whole volume of the earth's envelope, such being then fully formed only in so far as their lightly energetic matter may have contributed to its augmentation.

There can now be no difficulty in comprehending how the large fragments of rocks could have been urged over deep ocean bottoms, however uneven, by the immense force of these elevated waters thus so extensively formed and moving in mass. Their ponderosity being in the first place reduced about one third by the buoyancy of the waters, and in the next place the incumbent pressure upon deep waters not permitting their lower stratum to be readily displaced so as to pass over, or by such obstructions would have great and almost irresistible force in urging forward any such obstacle opposing their general forward motion; so that even massive blocks of granite, or any other rocks in the way of motion, were but comparatively little for these waters to have moved, the largest blocks being comparatively light when contrasted with the force of the whole moving ocean.

We see no way by which detached masses, however ponderous, could have resisted the full deep sea-force of such a moving avalanche of waters; that they should have been urged onward at the bottom of deep seas under all the superimposed pressure is certainly no cause of wonder, even were the ocean bottom often an inclined plane up which the waters would have to force them.

Thus we have the full interpretation of the recorded facts, so far as the erratic blocks and diluvial drifts so plentifully spread over the northern hemisphere, requires explanation, and which have been the cause of so much anxious inquiry and profitless speculation. They are certainly in perfect accordance with the conduct of nature, as we have contemplated her ways, and they are likewise confirmatory of our order of inquiry being of the right character. The more solid matter of a meteoric character that must have fallen during this period of so much aqueous accession, and the force of degradation and transportation of diluvial matter and massive blocks of stone, must have been so mixed in the general mass as not to be now recognizable.

Having now deduced the reasons for the geological formations of the earth in all their important phases to a finality, and having demonstrated causes for vast inundations of the earth by the forming waters, and more particularly for this last and not least important accession of aqueous matter, it will be readily perceived how very unfortunate and calamitous for intelligent beings it would have been had they been exposed to the earth's vicissitudes during any of the periods we have been contemplating; for at this last period of aqueous accession, if not often before, there could not have remained on the face of the whole northern hemisphere a terrestrial being having life. After the effects of this period of flood had passed away, the world would be in want of a new creation of creatures to enliven its surface and enjoy its blessings.

So that subsequent to this epoch, and as the lands began again to emerge from the waters of this overwhelming ocean, there must have been a renewal by reproduction of organic beings adapted to this changed condition; and however analogous antecedent types may have been to new forms, none of their prototypes could have been left to perpetuate their species. Therefore there must have been an entirely new creation or reproduction of subsequent forms, and with which none of their prototypes are found precisely identical.

By this we see that man was not the only organic being created after this epoch in which the world was deluged by her waters; and of one circumstance we are at the same time well assured, and that is, that man has no typical representative in any creature having existence anterior to the time of this sweeping flood; nor is there any evidence of the introduction of his race until very long afterward, which certainly says but little in support of the vestiges of creation theory. But contemplative creatures being created on our earth was itself a pledge to the species that the world would be no more exposed to such vicissitudes as had attended her progress of aggregation up to this time. And should there have been any exception to man's general immunity from a recurrence of such casualties, we shall now more readily comprehend how such may be accounted for. We certainly have a very straightforward account of such an occurrence having really taken place within the historic period of man, and thus a very ready method by which to account for such a catastrophe; for even though geologists have seen no signs of the Noachian deluge, which has induced considerable doubts with them of any such an event ever having occurred, still as we do know that it is in strict accordance with the manner in which the world received all her waters, and as the last accession must have been received some time or other, there is no reason why the deluge recorded in Scripture may not have been that last. And as it did not amount to another total extermination of living things, there is no reason why such an occurrence could not have taken place in man's time.

The very manner in which the catastrophe is recorded is certainly in accordance with what we have deduced to have been the character of all aqueous receptions. They were not, as now, the condensation of vapors exhaled from the earth, but they were the formations of water itself falling from heaven. The earth could never have accumulated or generated her waters simply by the condensation of vapors rising out of her own seas. "The windows of heaven were opened," is the forcible expression used by the historian in recording this event; no ordinary occurrence of the falling of rain would thus have been noticed. The historian was no doubt as well aware as we are now, that ordinary rains were occasioned by condensation of vapors; therefore they could not have intended to express a common rain by these words: "And it rained forty days and forty nights;" neither is this continuation of the same account very remarkable, unless the "windows of heaven" had been in a certain sense open and pouring down floods of new-formed waters, agreeable to the narrator's idea. Had we received but a simple statement of its having rained forty days and nights, there would have been in that nothing remarkable; it could only have conveyed the idea of such rainy times as even now frequently occur in some parts of the earth, but which would have been altogether inadequate to such an accumulation as would overflow the earth in the manner as stated. Now for this, if the waters only overflowed all of the earth known or visible to the survivors and narrators of the fact, it would be to them as if the whole world was equally inundated; for it may be assumed that they did not in those days know as much about the extent and condition of the world as we now do.

It would have required but an inconsiderable meteoric body to have occasioned such a partial overflow as this may have been, when compared with that which caused the diluvial transport. This meteor might have had the greatest portion of its matter transformed into water, in which case its incorporation with any area of the earth's atmosphere would certainly have occasioned the formation and fall of vast floods of water on that portion over which it had coalesced with her enveloping medium. The narrator of the deluge, and his tribe, may not have been immediately below where these aqueous formations were most abundantly falling, and very likely occupied some depressed plain into which these newly-formed waters would flow; and this flood, so far as he was concerned, as affecting him and his immediate cotemporaries, may have well been conceived to be over the face of the whole earth.

Now such a partial immersion of the earth would seem to be all there was of a deluge at that particular period, from the fact of the time stated for the dispersion of the waters, so as to allow the survivors to go forth upon the face of the earth, which they could not so speedily have done had the deluge been universal; for in that case, such a speedy disposition could not have been made of the waters. Now we do not insist on this deluge, either in support of our own system of creative development, nor that this deluge is proved by our system of deduction, but we notice the fact as simply showing that they are at least in perfect accordance with each other. Our principles or processes of inquiry are perfectly secure without the aid of the deluge in their support, and that is equally secure in the sanction it receives as being a fact in the sacred history of the human race.

This deluge not having left geological record of its ever having been, is by no means conclusive, and we may with safety affirm that the historic account of this transaction is in every particular in perfect accordance with what might have taken place agreeable to the general order of things, and that, too, without producing any such geological effects as can now be traced to any such an occurrence.

While these bodies were in the wide regions of space, and before reaching the utmost verge of the earth's envelope, they would, from their own general affinities, feeble as those might be, form centers of gravity for their own masses, round which their molecular forms would arrange themselves in the inverse order of their energies, as ruling the general mass into perfect spheres; but this general affinity being but feeble (whatever the magnitude of the bodies), could not cause sufficient compression to condense even their central and most energetic molecular constituents by denuding them of so much of their external atmosphere as to make them approach solidity. Therefore this spherical mass could have no solid nucleus, because the molecular constituents would retain in a great measure their spherical and expansive forms. The most condensed or central portions of these bodies would therefore retain a rate between gaseous expansion and solidity, while in outward progression their matter would become of a more and more etherealized character.

Now the consequence of such a body coming in coalition with our earth's envelope would be at once to dissipate its molecules among that with which it had thus coalesced; but those more affinitively affected portions being deprived of their atmosphere by penetrating into the pressure of this envelope, would again concentrate in the re-formation of other globular forms of the more affinitive matter, which by progressively descending and leaving their lighter matter among that of its own grade, through which, by its own specific gravity, it could not descend, portions of these visible meteoric bodies may thus occasionally reach the earth's surface in solidity. Some portions of the matter of most of these coalescing bodies may be expected as sufficiently energetic to be of a solidifying character when under the influence of this enveloping compression, in which case they would continue their aggregation and descent by being thus divested of their lighter and unsolidifying portions in the progressively densifying medium down through which they were passing, and thus ultimately in some instances reach the earth in solidity, exhibiting themselves in those meteoric masses that have been so frequently found. These occasional falls to the earth of such meteoric substances are occasioned by the rapid descent of this solidifying matter; for by the densifying friction of the medium through which they are falling they become so highly ignited as at times to explode their mass; in which case their fragments explode upward, and thus retarded of their motion are thereby reduced in temperature, so as at times to reach the earth without their total dissipation, while those portions that are exploded downward increase their velocity and temperature, and thereby become totally dissipated in the frictional medium that thus ignites them; and this is the usual disposition which our earth's enveloping matter makes of such bodies thus descending, either from space or through its own substance.

We must now perceive that these meteorolites are much changed in magnitude and density; for by coalescing in the first place with the earth's envelope, their velocity would be all but extinguished and the whole body dissipated in this medium; but the most affinitively attractive molecules thus disseminated would again aggregate themselves into new globular forms, accumulating, condensing, and descending through the insensible medium in which they were first suspended, something after the manner of the aggregation of hailstones in the common atmosphere, until the velocity acquired, acting upon the progressively densifying medium through which they were falling, would cause such increase of temperature as totally to dissipate them before reaching the earth.

Thus we see that any meteoric substances or cometic bodies yet remaining in space unappropriated will be received by the earth with perfect safety to her inhabitants, situated, as they are, so far from the earth's exterior, through which these bodies are made to descend without any destructive effect.

There now remains but one more great problem in phenomenal nature, with reference to past and present conditions, that requires to be solved, one which has never yet on true philosophical principles had any thing like a satisfactory solution, namely, the cause of the great and manifest change that has taken place in the temperature of the earth between primitive and present times.

Geologists, and physicists in general, have speculated not a little on this subject, but with all their inventive or imaginative powers they have entirely failed to meet the case. They have found unquestionable evidence of the fact, that the temperature of primitive times was far more equable than it now is; but the fact is all they have found; with them there is no assignable cause that is consistent with the facts they perceive, no rule of physical law why this should be the case, and so the matter remains with them as much of a mystery as ever. They find that in high northern latitudes terrestrial plants must have flourished in tropical luxuriance, and were, in fact, the prototypes of such as are now found only in the tropics. Evidence of this is plentifully furnished by floral remains, so abundantly found in many of the coal measures, without reference to high or low latitudes, as to render the general fact no longer questionable. This testimony is found in every system of rocks, from the impressions of first-observed organic protoplasts to the most perfect and ultimate forms, as now adapted to the vicissitudes of the seasons of our own times; but this testimony does not seem to tell of a continued uniformity of temperature up to any particular period, and a sudden revolution from that to present conditions but indicates a more progressive transition of temperature; but while finding all this unquestionable evidence of the fact itself, they have not the most remote suspicion of the causes leading to so remarkable a change, even while the evidence of the change and its cause are as palpably conspicuous in the rocks that record it as they are in the monuments that testify to its truth, all being found together and readily interpreted.

Geologists contemplate the superposition of rocks upon rocks, and systems upon systems, until they arrive at the conclusion that the average depth of the earth's stratified deposits must be somewhere from seven to ten miles. They find the northern hemisphere affording far the widest scope for geological explorations, that containing over two thirds of the earth susceptible of such investigation, by being above the ocean. And they find in all these systems of rocks, now so far above the present ocean-level, monuments testifying to their having been primarily submerged beneath the seas; so their supposition is, that all lands have been heaved up from the bottom of the primitive ocean. Were we to admit this fact, we should certainly inquire, What became of all the waters whose places the lands now occupy? Some disposition must have been made of them, though geologists have let them find a place for themselves, without attempting to account for where they could have gone. If they went into the present seas, they must have been elevated because of such accession, for there was at least a third of the whole mass of waters to be accommodated; and a third added to the present ocean would leave most of the land too moist for cultivation. The lands may not occupy the entire third of the earth, but if heaved up, they must have displaced more than a third of the waters, because of the heaving up at the same time the bottom of the ocean into shallow margins all round the raised lands. To dispose of these waters will cost them no trouble, as they are in the habit of making the earth heave up or sink down at pleasure, and any part of it, however much or little, as will; they will readily adopt the alternative of sinking the southern hemisphere in the same ratio as they make the northern one to rise, and thus by this means prepare for the displaced waters. Be that as it may, it is very evident that the northern hemisphere has far more land elevated above the ocean than the southern hemisphere has, and it is certainly very evident that the two hemispheres must be at least thus much from being equal. Has the idea never occurred, that changing the relative quantities of matter in the two hemispheres may at the same time have changed in some manner the position of the earth? Is this circumstance of at least two thirds of the lands being north of the equator to remain forever, both with geologists and astronomers, a perfect abstraction, idea, or fact from which nothing is either deducible or inferable! Geologists are well aware that this was not always so, and still they are satisfied that the earth swings on as usual without being disturbed by her continents and islands rising out of the ocean, and thus farther from the center of gravity than before, or at least farther from her equatorial plane. We should suppose physicists would have found this effective of something.

The whole geological superstructure and science of its facts consisting in the construction of rocks and systems of rocks—and their relative positions, both with respect to each other and the general oceanic level—we should have supposed that in the researches made by that class of physical explorers among the formations in which they have discovered such unmistakable evidence of a higher general temperature than the present, that they would have fallen upon some train of thought which would have suggested the idea that these very rocks, and their elevations above a general sea-level, may have been themselves the very cause of this progressive revolution of temperature; for how could the northern hemisphere have had such geological systems heaped upon it more than there is in the southern half of the globe, without effecting some change in its motion?

Were the earth suspended in space without any annual motion, she would, as we have before stated, have no rotary motion on her own axis; the consequence would therefore be, that her pole would be perpendicular to the center of solar attraction, because of the more ponderable nature of the northern hemisphere; and her pole being the line of the attractive equalization of her own matter, as resolved by the general affinities of the two hemispheres, as balanced in their present position by equatorial revolution, were it not for this revolution the north pole would point directly to the sun, from the excess of matter, making the northern hemisphere more sensible to the sun's attraction. And even with the present annual motion round the sun, had the earth no equatorial enlargement, she would not even then rotate on her axis at all, because of this northern enlargement; her present axis, in such a case, would become permanently inclined, by the composition of the forces of projectile momentum and solar attraction, and at what angle mathematicians may readily calculate, when they procure the relative amounts of these special expressions of force.

In this case the earth would hold the same relation to the sun that the moon now holds to the earth, in so far as always to present the same face, which condition would render one whole hemisphere such a waste as was never intended. But the earth having now this equatorial enlargement, together with a protuberant northern hemisphere, her affinitive conduct toward other bodies must now necessarily be in all things comformable; but, as we have already seen, her affinitive relations with respect to position could not have been always as they now are. The earth's annual revolution round the sun being then the necessary resultant of the combined forces which could have effected it, and this revolution round the sun being as necessarily productive of her rotation on her own axis, and that as a consequence, would as surely resolve her spheriodicity of form, which, together, would most assuredly determine a perfect coincidence in the planes of revolution and rotation, and particularly while her matter was still susceptible of assuming such form, or while the accessions contributing to her enlargement were in a condition to conform to this centrifugal motion. Therefore the difference in her structural condition between primitive times and the present must be, from that of a perfect spheroid to that of her present irregular form.

This uniformity of surface and perfection of spherodal form could have continued no longer than she was receiving substances whose matter could accommodate itself to a fluid level by the force of its own gravity; and so long as this was the case, the spheroid would continue its form by the momentum of the earth's rotatory motion, and then the plane of this rotation would perfectly coincide with the plane of the revolution round the sun, so that there would then be a uniformity of sunshine from pole to pole, that is, twelve hours sunshine and twelve hours shade, with a perfect uniformity of temperature. But the earth, at this early time, not having acquired her present proportional quantity, would not have rotated quite so fast on her axis as now.

Now, when it is so palpably evident that revolutionary motion round the sun, begat rotatory motion, and that this rotary movement must have induced an enlargement of the equatorial circle, with its maximum in the plane of its motion, and that the momentum of rotatory force acquired by this excess of enlargement would necessarily resolve this plane into perfect coincidence with the plane of the ecliptic, why has it never occurred to physicists that hemispherical enlargement would likewise beget an excess of motion proportional to the momentum of the extra quantity acquired, and its relative situation with the equinox, as compared with the opposite hemisphere? Surely such must have been the effect of any such disturbance of gravitating equilibrium.

The northern hemisphere, therefore, from the period of the earth's most perfect spheriodicity, having progressively acquired much more matter than the southern hemisphere, and being from this more ponderable, would necessarily begin to rotate in advance as it were of the southern, and this change would progressively increase as it continued to acquire its accessions, so that were the earth now separated in the plane of her equator, the northern portion would, from its greater inertial capacity, rotate in advance of the opposite half; but this being impossible, it will nevertheless be seen that the northern hemisphere, because of this excess of momentûm, must always be in advance of the southern hemisphere; consequently the pole of the earth can not be at right angles with the plane of her orbit, as it was in early times when there were no irregularities of surface-level, and the earth's form a perfect spheriod, and when, as a consequence of this uniformity, the plane of revolution and rotation were the same; for as the northern hemisphere gained solid matter in excess of the southern hemisphere, so would the pole become oblique in the ratio and situation of such excess because of this increase of its momentum, so that its position would be the resultant of that composition of centrifugal forces caused by the inequalities of the earth's sphericity on the equator and northern hemisphere; so that by this composition of forces, caused by the inequalities of the earth's sphericity, we have the present inclination of the earth's pole to the plane of the ecliptic, which is the cause of the existing vicissitudes of the seasons. And we perceive that this change must have been gradual, as the earth was accumulating her deposits for her geological formations, and more particularly the disproportional increase of her northern hemisphere.

Thus is this great mystery of the earth's climatial change, as respects the discrepancy of temperature between what it was in primitive times and the present period, now solved, and in a way that is not only in perfect accordance with the geological teachings of the rocks, but it is at the same time suggestive of an astronomical feature in the earth's formation that it is not well to overlook when deciding on the unchanged condition of the earth's relative attitude, as astronomers have done; for however insignificant they may be disposed to regard the earth's inequalities of surface, we have here full demonstration that they are significant of a great change, which must (because of them) have taken place in the position of the earth's pole of rotation to her plane of revolution. This changing exposure of the northern and southern hemispheres to the sun now begetting the vicissitudes of the seasons, must have been caused by a progressive change in the earth's attitude while these inequalities of surface were in process of being formed, for all this ponderable matter could not have been so deposited without producing such an effect.

We now assume that we have verified our pretension, that we have redeemed our pledge in the introductory propositions, when we thus present to the world this system of inorganic nature and its laws more certain than mankind have yet seen, and because of being in accordance with the eternal truths of nature, must continue good for all time; at least it will be found much less readily subverted than any physical or cosmical scheme that has heretofore been introduced. We have endeavored to give a general idea of how this problem of the universe is to be solved, so that mankind may thereby perceive the process of creative development as much as if he had been a constant witness of the workings of the Omnipotent Operator, from the first inception of physical nature outward and onward to all its conclusions forever. Although we may not have noticed the effect of relations in all their severality of detail, we have more than furnished a key to the kingdom of creative development by which the mind of man may master all the mysteries in the phenomenal phases of physical nature, and become familiar with the most secret workings of the Eternal Will. This we acquire by fully comprehending the effect of the everlasting laws that govern in God's physical kingdom, and perceiving their relation to the phenomenal facts, whether in endless unity or their expressions in infinite severality, containing the measures and modes by which the wide-spread universe was wove into all the complicated conditions of its unital whole. But when we have achieved all this by aid of ultimate law, magnificent as it may be, we have still but the body of the universe without the soul, which, when regarded alone, would be calculated to cause an unsatisfactory and soul-searing pantheism; but it never can be so regarded by minds calculated for its contemplation; the evidences of infinite intellect are too impressively stamped upon every lineament in the physical feature for that, and with the moral government of God it has nothing more to do than as the means by which Omnipotent Mind makes sensible expression of itself.

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